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ELECTRICAL REVIEW.

VOL. XXXVIII. JANUARY 3, 1896 No. 945.

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POLYPHASE MOTORS.

IT is becoming more apparent that the polyphase motor does not take the important position in practical engineering that its advocates predicted for it. The ordinary continuous current motor working up to 500 volts pressure is hard to beat—true it has a commutator and brushes requiring some attention—but this attention is almost a negligible quantity with well made machines. Polyphase motors fill the demand for higher pressures in long distance transmission of power, and they also meet the requirements of fiery mines.

In every motor a starting resistance is required in series with the armature, hence most polyphase motors require some sliding contacts in connection with this starting resistance. That being so, these motors are not entirely commutatorless.

For mining work, where absolute safety is paramount, and efficiency a secondary consideration, the starting resistance is dispensed with by winding the armature with high ohmic resistance. This makes the armature $C^2 R$ loss greater, and reduces the efficiency by 15 per cent., but that loss is nothing compared with the simplicity and safety of the polyphase motor working far underground.

In many other places, however, efficiency is the first consideration, and the separate starting resistances and sliding contacts are then required, hence the question at once arises, wherein does the polyphase motor possess advantages over the ordinary continuous current machine? Only in the absence of the commutator. That, in some cases, would decide in favour of polyphase machines, and in those instances where pressures exceeding 1,000 volts is desirable the polyphase machine is the better.

The motor business in this country, so far as supplied from street mains, is miserably small, but the work going on in isolated plants is growing rapidly, and motors are being introduced in large numbers into mines, mills, factories and works, where the electric supply can be generated at less than 1d. per unit. Hence the polyphase motor may be studied from its different aspects with advantage at the present moment.

The perfection of these motors has been accomplished not by their originators, but by many later workers; the early patentees sit tight and see others spending time and money in developing the machinery, and then swoop down upon them.

In this country, however, we have two prior publications, which ought to effectually prevent the obtaining of any broad claims over polyphase motors. The publications of Ferraris and Baily gave to the world the principles and fundamental designs of the induction, or polyphase motor, before any patents were applied for.

Whether the advantages of polyphase motors are so great as to warrant any firm entering upon a contest against patent claims is very doubtful, for so long as we have the common motors free it will be found possible to carry out nearly

every motor application without the polyphase system. It is not an indispensable method in electrical engineering.

In some continental towns polyphase currents are used. For instance, on the river Iser, near Munich, two 340 kw. three-phase alternators are driven by water-power, and the energy is transmitted at 5,000 volts over five miles to Thalkirchen, where about 500 H.P. is utilised in three-phase motors ranging from $\frac{1}{8}$th to 50 kw. units.

Here we have an instance of the advantages of polyphase systems with a cheap and plentiful water-power at a distance, to be transmitted and distributed for both power and light; such favourable circumstances are, however, very rare in our country.

Tramcars for Mechanical Traction.

A CORRESPONDENT of the *Revue Internationale de L'Electricite* remarks that in Paris they have persisted in applying mechanical traction to vehicles of very unsuitable type, and compares them to veritable fossils—mastodons—and asks the reason of this persistence and the constant increase of size as compared with small double platform cars in other cities. He cites the cars on the St. Denis-Madeleine route as an example of very large electrical cars, and on the Vincennes St. Augustin route of air compression cars of still larger size, whilst on the Gennevilliers line, the Serpollet system has cars which are described as veritable ships. A new line he describes as soon likely to have self-moving castles if this sort of thing goes on. He asks, would it not be practicable instead of 20 huge 50-place cars at 10 minutes intervals, to employ 25 or 30 cars of 36 places at 3 minutes intervals. He favours the use of double platform or shuttle cars with brake and driver's gear, &c., at each end, so enabling a car to run either way and perform any portion of a journey, turntables being not required as they now are, and he says that two criticisms may be made: first, that there is a mania for large, heavy, and cumbersome vehicles, which would be better replaced by light vehicles, neat and handy; secondly, the use of turntables should be given up, as they are necessary for only the huge vehicles which cannot move save in one direction.

The Luminosity of Welsbach Hoods.

THE cause of the great increase in the luminosity of gas flames when the oxides of the rarer earths are introduced into them, has recently formed the subject of an interesting investigation by Dr. Westphal, of the Charlottenburg Technical Institute. He was led to investigate this subject on learning that attempts made in America to produce a pure white light by impregnating the filaments of glow lamps with incandescent oxides, had been unsuccessful. Dr. Westphal made experiments to discover the conditions under which an incandescent hood gives out light. It was found that mere heating of the hood does not make it luminous; in a platinum crucible with a cover on, the hood gave no light even over the blow-pipe flame. To test whether the luminosity was due to the evaporation of the oxides, incandescent bodies of different systems were heated in combustion tubes till the glass softened. The different gases which it would be possible to find in the zone of a Bunsen flame were drawn, one after another, through the heated combustion tube. With air, a rapid evaporation of the oxides took place but there was no light whatever produced. Oxygen, hydrogen, steam, carbonic oxide, carbon dioxide, and acetylene were tried in the same way, but in no case was there any emission of light. In hydrogen flames, in carbonic oxide flames, and with more difficulty in acetylene flames, the incandescence oxides glowed brightly, and this showed that the emission of light did not depend on high temperature alone. Dr. Westphal is inclined to the view that the luminosity of the hood is due to chemical reaction. This is supported by the fact that incandescent hoods glow by far most brightly at the outer limits of the Bunsen flame, though this is not the hottest part of the flame. Either the oxide is reduced by the hydrogen or the carbonic oxide to a sub-oxide and is re-oxidised by the oxygen of the air at a high temperature with emission of light, or a superficial condensation of gases goes on which, when so condensed, burn with a specially bright light. The latter view agrees with Frankland's well known experiment of burning a gas, such as hydrogen, which at ordinary pressures give a non-luminous flame. When he exploded a mixture of hydrogen and oxygen under considerable pressure in a glass vessel, a brilliant luminosity was produced. It has been pointed out, however, by some of Dr. Westphal's critics, that the temperatures produced in his experiments with the platinum crucible and the combustion tube are far below that of the Bunsen flame. The high temperature theory, however, appears to us to be incapable of explaining all the results obtained by Dr. Westphal. The rays of higher refrangibility emitted by the oxides in the Welsbach hood would be a very desirable addition to the light of the glow lamp, and such investigations as those of Dr. Westphal may yet show how they can be utilised.

Lighthouse Illuminants.

In a recent issue of *Nature*, there is a paper in which are reviewed the recent improvements which have taken place in lighthouse illumination. Although the paper is unsigned, we fancy we can recognise the "image and superscription" of one who has a well known bias in favour of gaseous illuminants. And this, presumably, is the reason why he attaches so little importance to electric illumination. It has always been a matter of surprise to us that some of our competent arc light manufacturers have not given this subject more attention. Possibly they are deterred by the difficulties of approaching the Trinity House and other Boards that have control of the lighting arrangements around our coasts. Optical experts are certainly making headway, and they have given increased power and facility of working, but, hitherto, the oil and gas advocates have had matters pretty much their own way. And this in spite of the wonderfully encouraging results which have been obtained at St. Catherine's Point, La Heve, and elsewhere, with the electric light. No one, probably, save the ultra-biassed, can be found who will place the electric light below that from oil or gas lamps in efficiency and power; yet, why are there not more lighthouses around our coasts using it?

The Utilisation of Accumulators as Resistances.

M. NODON directs attention to the advantages of using accumulators as a substitute for resistances in electric installations, in an article in the *Revue Internationale de L'Electricité*. It goes without saying that a considerable amount of energy is absorbed in resistance coils, which is irrecoverably wasted in heating the surrounding air. If a battery of accumulators is substituted for such a dead resistance, the electric energy, instead of being lost, is in great part stored up in a form which may be afterwards utilised when required. M. Nodon quotes an example of an installation in which this principle was taken advantage of. A Gramme dynamo driven by a 2-horse petroleum engine gave a current of 30 ampères at 75 volts. This dynamo was coupled to four differential arc lamps arranged in parallel, and each taking a current of 8 ampères. Each of these lamps was fitted with a German silver resistance to reduce the voltage of the machine to the required amount. At one lamp the resistance was replaced by a battery of 10 Faure accumulators which were charged during the working of the lamp with a current of 8 ampères. The lamp with the battery was observed to work much steadier than those with the wire resistances, and sufficient energy was stored in the accumulators to light five 10-candle lamps during the whole night. With alternating currents it is proposed to use a rotary transformer to charge the battery. M. Nodon ends, however, by confessing that the use of accumulators as resistances is not likely to become general till their first cost and cost of maintenance has been considerably reduced, and expresses a fervent wish that this may soon take place, in order that their great advantages when used in this way may be realised.

THE ELECTROLYTIC ACTION OF RETURN CURRENTS IN ELECTRICAL TRAMWAYS.

BY JOHN GRAY, B.Sc.

THE discovery that the earth cannot be safely used for the transmission of large return currents has been one of the unexpected outcomes of the extension of electrical tramways in towns. The gas and water mains, armoured cables, &c., in every large town, form a network of uninsulated conductors everywhere in contact with the earth, and any current flowing between two points on the earth's surface will be partly carried by these underground conductors. At the surface of contact between the pipe and the earth where the current enters the pipe, no harm is done; in fact, one would expect that the natural process of corrosion would be arrested or reversed, and the pipe surfaces brightened. But at the surface where the current leaves the pipe, corrosion will be accelerated by an amount proportional to the magnitude of the current leaving the pipes. The activity of this corrosion will depend to a certain extent on the moisture and salts in the soil, but in no case is it likely to be absent.

In the single trolley system, which has hitherto been most extensively adopted for working electrical tramways, the return currents are discharged from the car wheels to the rails, and as these are not insulated from the earth, the earth forms a shunt circuit with the rails returning to the power house, and takes a proportion of the return current depending on their relative conductivities. The amount of stray current carried by the earth and its buried pipes, &c., is by no means inconsiderable; it has been found to amount to as much as 40 to 50 per cent. of the total return current in tramway systems without rail feeders.

An extensive series of experiments has been made by Mr. Stuart Smith* on the gas and water pipes in San Francisco, to determine their potentials relative to each other and to the tramway rails. He found that there was a zone in the neighbourhood of the power station, where the pipes were positive to the rails, then a short neutral zone, and beyond that a zone—by far the largest—where the pipes were negative to the rails. The resistance of the pipes was found to be made up almost entirely of the resistance of their joints, the section of metal in the pipes having very little influence. This fact explains the unexpected result that the resistance of the gas pipes was found to be rather less than that of the water pipes; the joints of gas pipes having usually less resistance than those of water pipes. This discovery of Mr. Stuart Smith's, that the resistance of underground gas and water pipes is located almost wholly at their joints, has an important bearing on the remedies proposed for getting rid of electrolytic corrosion. In many of the proposed plans, the current in the pipes is increased instead of being diminished. Evidently at each high resistance joint a stray current will pass round the joint through the ground, and accelerate corrosion where it leaves the pipe surface in front of the joint. Unless gas and water pipes have been laid down with joints of good conductivity, any effective scheme for reducing electrolytic corrosion in these pipes must reduce the current flowing in them to a minimum.

Although electrolytic corrosion from electric tramways is much less than sensational newspaper articles would lead us to believe, yet it is going on steadily, and may be expected eventually to cause much trouble. It is advisable, therefore, that steps should be taken from the first to obviate or minimise the damage done to neighbouring property.

Mr. Wilkinson, in his "Notes on Electric Tramways in the United States and Canada,"† has given a sketch of the various phases which this question has gone through in practice in America. He says: "As the earth presents an almost infinite mass compared with the rails, it was assumed, in the first instance, that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated inquiry into the losses in transmission of electric energy. On many lines of five to ten miles, the voltage at the most distant section between trolley wire and rails was only 50 per cent. of that generated at the station. Some improvement was made by sinking deeper earths into moist soil and connecting the same to more distant points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductors." The conductivity of the rails was improved by bridging over the high resistance joints by iron and copper bonds. In the next stage, the rails were connected at intervals to the water and gas pipes, a step which created a satisfactory reduction of resistance in the return circuit, but led to a great increase of electrolytic corrosion and pitting of the gas and water pipes. To mitigate this action, the affected parts of the pipes were connected by cables to the negative poles of the dynamos. This led to the use of a supplementary wire consisting of a bare copper rod, laid between the rails, and connected to the rails on each side of the fish plates. But, as this supplementary conductor made no allowance for the increase of the current as the power station was approached, it was considered better to adopt separate return feeders connected to the rails every 500 feet, these feeders being increased in section and number as the lines neared the generating station. These feeders were not insulated, and consequently they were only a partial improvement on the supplementary wire.

Mr. Wilkinson considers that the separate feeder system would completely get rid of the stray currents if they were insulated. He says, "Let the negative poles of the dynamos be connected to the rails direct by insulated cables, but not to the earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables." This view of Mr. Wilkinson's appears to be erroneous. There will still be a current from the pipes to the earth under the end of each feeder where it is connected to the rail. The corrosion will therefore not be got rid of by this plan, but only more widely distributed over the pipes. That, in itself, of course, is an advantage, but something more requires to be done.

Mr. Jenkin, in the discussion on Mr. Wilkinson's paper, pointed out that the only way in which we can completely get rid of stray earth currents when using earthed rails in the circuit is to maintain all parts of the rails at the same potential. This could be perfectly carried out only by using an infinite number of insulated rail feeders which, of course, is out of the question in practice. Mr. Jenkin calculates that to keep within the Board of Trade limit of 7 volts P.D. between any two points of the rails, the insulated feeders would have to be connected to the rails at points two miles apart; or, if the rails were also utilised to carry part of the return current, at points half a mile apart.

Mr. Jenkin shows that there are two distinct ways in which the potential of the rails can be regulated at the return feeder points:—1. By adjusting the resistance of the return feeders so that they have all the *same drop* when equally loaded. 2. By working the return feeders at the *same density*, and therefore with a drop depending directly on their length. In the first case the return feeders are run in parallel at the station off dynamos in parallel; in the second case, the feeders must be run off separate dynamos at different voltages, or some device must be used to vary the voltage. Calculations show that feeders worked on the uniform density principle are the cheapest, but lead to more complicated apparatus in the station than the other system.

This system, though more perfect than Mr. Wilkinson's, does not completely get rid of electrolytic corrosion, since there will always be numerous points near the ends of the feeders where the pipe systems are positive to the rails, and where they will, in consequence, discharge current to the earth. To get over this difficulty, a simple plan has been introduced by Mr. Harold P. Brown,* which is considered by Mr. Edison to be the only satisfactory method of preventing electrolytic corrosion in connection with electrical tramways. Mr. Brown's plan is to keep all parts of the underground pipes at least a few volts below the rails and the surrounding earth. If this is carried out there can, of course, be no current passing anywhere from the pipes to the

* *Electrical World*, Vol. 35, No. 12.
† *Journal* Inst. Elec. Engs., V. 23, p. 631.

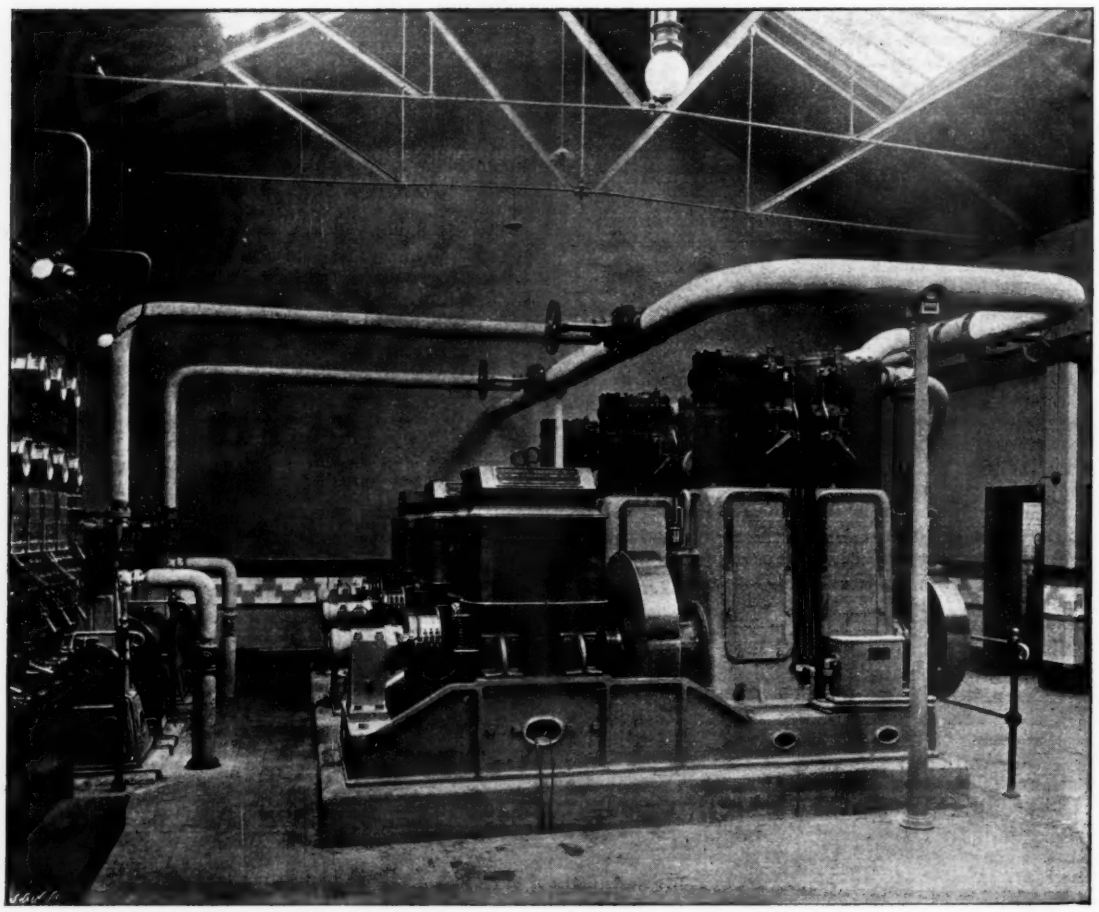
* ELECTRICAL REVIEW, April 19th, 1895.

earth, and consequently no electrolytic corrosion of the pipes. Mr. Brown attains his object by connecting the pipe systems near the power house by an insulated feeder to one of the dynamos with a voltage 12 volts in excess of the normal voltage of the other dynamos whose negative terminals are connected to the nearest point of the rails. This has the effect of keeping the pipes near the power station a few volts below the rails above them, and, of course, puts the potential of pipes still further off, below that of the rails by a greater amount. The drawback to this plan is that it considerably increases the flow of current in the pipes, and thereby increases corrosion at high resistance joints. Mr. Brown obviates this somewhat by prolonging his insulated feeder and connecting it to the rails at their most distant point, whereby the great difference of potential between the rails and the pipes at that point is reduced, and the consequent flow of current through the pipes. Though this system is cheap, and considerably reduces corrosion, there must still be a considerable current in the pipes, and, in view of the results of Stuart Smith's experiments already mentioned, this must always produce considerable corrosion in the course of time at the pipe joints. A combination of Mr. Brown's system with the equipotential rail system proposed by Mr. Jenkin, would lead to an improvement on both systems, as only the comparatively small stray currents between the feeder ends would be collected in the pipes, and harmlessly drawn off by Mr. Brown's clamp and insulated feeder.

By such devices, there can be no doubt that electrolytic corrosion of pipes, if not completely eliminated, can be very much reduced. Whether the steady action of these reduced stray currents for many years will increase the natural rate of corrosion of pipes, &c., to such an extent as will give the companies concerned a claim for damages, remains to be seen. Up to the present there is no sufficient evidence that this is the case. The legal decisions, such as that in the case of the telephone company and the Leeds Corporation, appear to protect the tramway companies, provided they adopt the best means known for preventing damage by earth currents. If future developments should induce either the Board of Trade or the courts to demand the entire suppression of stray currents, electrical tramway companies can always fall back on the double trolley system, or some similar system in which no part of the circuit is in connection with earth.

THE ELECTRIC LIGHTING OF WALSALL.

The system of electric lighting which has been introduced into Walsall by the Corporation is that known as the Oxford system. Since the works at Oxford were designed, however, many improvements have been evolved, and it may be said to have advanced further into the region of automatic arrangements. The most notable departure from the methods employed at Oxford is the complete control over all the distributing mains that is obtained at the central generating station. Previously the distributing mains from a sub-station were controlled to a great extent at that sub-station, but this is now done from the main switchboard at the central station. One naturally expects some complication with such a system, and though it seemed to work admirably it was not easy to follow out the arrangements in a cursory examination.



View of Engines and Dynamos.

Like many other provincial bodies, the Walsall Corporation were very deliberate in considering the subject of electric lighting. The matter may have been thoroughly examined, but the process was distinctly slow. The Corporation obtained a provisional order in 1890, but did not proceed any further till 1893, when tenders were accepted.

The system of the high pressure continuous current, with motor transformers, was recommended by Mr. F. Brown, of Walsall, who had been called in by the Corporation to act as consulting engineer. There was no doubt some justification for adopting this system, Walsall being an exceptionally widely scattered district. The electric lighting station is situated at the old gas works of the Corporation, which have been abandoned for the manufacture of gas.

The building which contains the plant has been practically remodelled from an old retort house, the boiler house, with the exception of a new roof, being practically in its original condition. The building, it might be mentioned, is situated on the banks of a canal, from whence coal is easily transhipped.

The steam raising plant consists of two Lancashire boilers made by Messrs. H. & T. Danks, of Netherton. They are 30 feet in length and 7 feet diameter, and work normally at a steam pressure of 125 lbs.; they are each supplied with Hopkinson fittings. Two Worthington pumps, each of which can feed the two boilers, are fixed in the boiler house, and close by is a Brown-Berryman feed water heater. This is the ordinary feed water heater made by Messrs. Wright, of Tipton, but includes some improvements made by Mr. Brown. This feed water heater is placed in a bye-pass of the main exhaust, the heater being drained in the usual way.

There are three sets of generating plant, the engines of which have been supplied by Messrs. Bumsted & Chandler; they are compound engines, each of 120 I.H.P., having 15-inch low pressure cylinders, and 10½-inch high pressure cylinders, running at a speed of 350 revolutions per minute, with a steam pressure of 125 lbs. per square inch. There are also two compound exciting engines, each of 15 I.H.P., with 5¾-inch low pressure cylinders, and 4-inch high pressure cylinders, running at a speed of 550 revolutions per minute, with 125 lbs. steam pressure. All engines exhaust to the atmosphere for the present. Each engine is fitted with Winn's patent drop sight feed lubricators of the latest type, having a coil condenser.

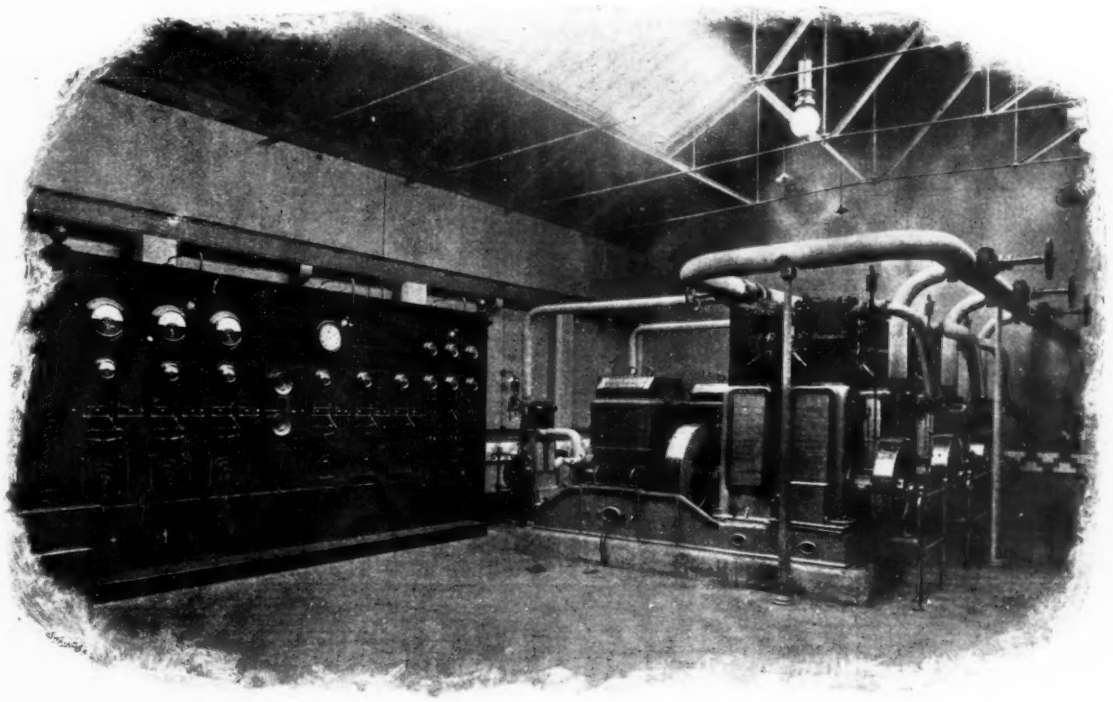
The Bumsted and Chandler engine, although much used in the early days of electric lighting, has for some time been absent from large central stations. Its running is, however, most excellent, and on the occasion of a recent visit to Walsall we were much impressed with its noiselessness in working.

The engine is, of course, single acting, having its parts in constant compression.

Generating Plant.

Combined with these engines are three separately excited two-pole machines, which are mounted on an extension of the engine bed-plate, each machine being capable of giving an output of 40 ampères at 2,000 volts when running at 350 revolutions per minute. For exciting purposes there are two shunt-wound machines, each coupled direct to "Chandler's" engines, and giving 60 ampères at 100 volts, and capable of running up to 135 volts for the purpose of charging the station battery. In the station are 57 K. 11 E.P.S. cells for lighting it and exciting fields of generators.

The main switchboard is divided into various sections, everything, as we have already said, being done at the station, with the exception of putting the sub-station accumulators int circuit.



Engines, Dynamos, and Switchboard.

There are three generator panels made of slate, each fitted with ammeter, double-pole automatic magnetic cut-out and main switch, 17-way field regulating switch, ammeter for field circuit, and a switch for opening field circuit and short-circuiting the same on itself.

On each exciter panel is an ammeter, two double-pole switches and fuses for connecting exciters to bus bars or accumulators, and a 9-way shunt regulating switch. A battery panel contains an ammeter, two double-pole switches and fuses, and a 6-way regulating switch.

On another panel are fitted two "Kelvin" voltmeters, each reading up to 2,100 volts, one being connected across main bus bars, and the other to 3-way double-pole plug switch for paralleling generators.

On the transformer (feeder) panels, of which there are three, composed of slate, is an ammeter, double-pole automatic magnetic cut-out and main switch, 33-way transformer starting and regulating switch, single-pole switch for short-circuiting pilot wires. Resistances are provided for starting and regulating each of the transformers, which are connected up to 33-way switches.

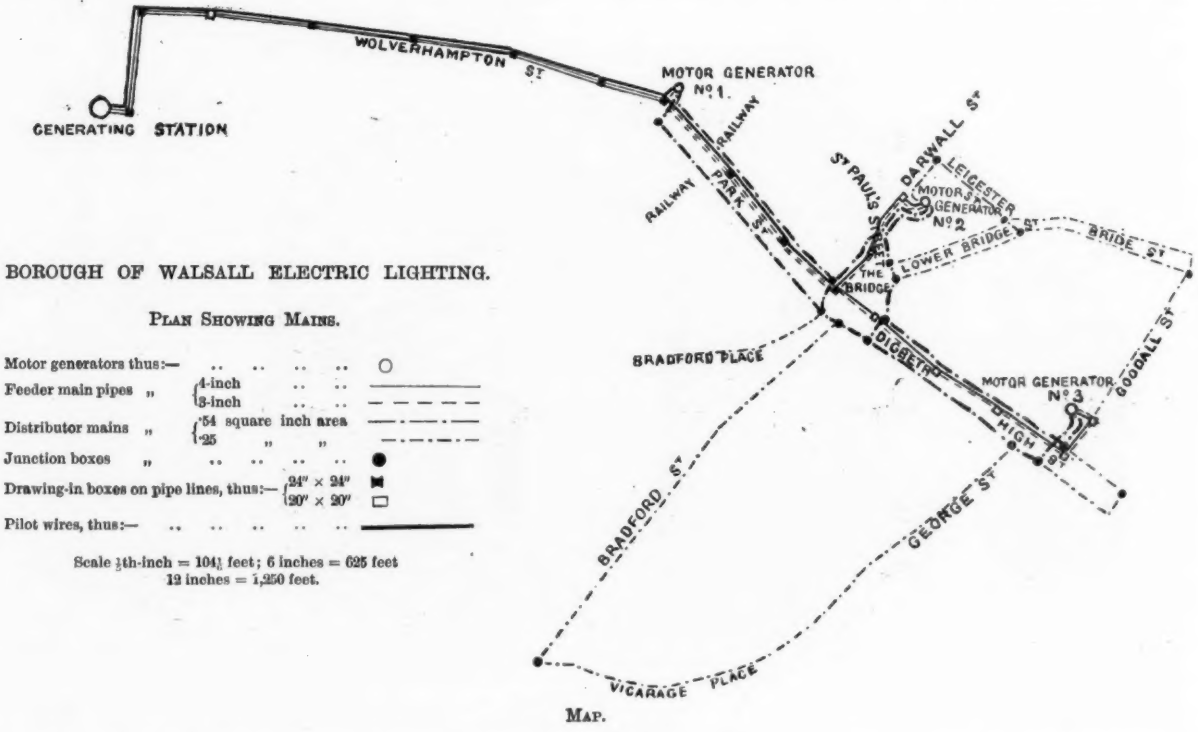
Above the panels of the switchboard are two voltmeters for exciters, a voltmeter for the battery, and three large dial pilot voltmeters indicating E.M.F. at feeding points.

Before leaving the station, it is important that we should refer to the steam pipes which have been arranged on the ring system, so that any machine can be cut off if necessary. The steam pipes are of wrought-iron, with flanges of ample thickness welded on, and are made by Messrs. John Russell and Co., of Walsall. The steam pipes in the engine room rest on pillars, but both in the walls and on these pillars are iron rollers, which allow of considerable movement of the pipes due to expansion. At the extreme end of the steam pipe double rollers are employed. Hopkinson fittings are used throughout the pipes. The exhaust steam pipes are laid in an underground trench, and led to the feed water heater, and afterwards exhaust into the atmosphere. Outside the boiler house ample accommodation is provided for storing coal, there being in fact room for holding three barge loads of coal, and there is sufficient room on the side of the boiler house to accommodate another. The coal which is used is, owing to the proximity of the coalfields, naturally cheap, the cost being 5s. 6d. per ton. The main exhaust pipe comes out on this side of the station about 7 feet from the top. The size of the exhaust pipe is 13 inches; to prevent condensation it is lagged all through. From this exhaust main a trench is led into the canal.

Sub-station Plant.

There are three sub-stations, the principal one being at the St. George's Hall, where the secondary battery is arranged. We have managed to secure a photograph of this, which shows the high tension side of the machine, as well as the long range switch. In each sub-station is a main transformer, giving an output at the secondary terminals of 105 volts, 400 ampères, when supplied with primary current at 1,950 volts, running at a speed of 550 revolutions per minute. The bearings are fitted with automatic lubricating pumps in addition to rings giving continuous lubrication. The field magnets have two windings, the one being in series with the primary high-tension armature, and the other as a "shunt" across the low-tension armature. A long range switch is provided with each of the main transformers, its purpose being to close the secondary circuit from the transformer to the network, it being operated from the central station; the magnet coils being wound with wire in series with the pilot wires. Combined with this switch is an automatic magnetic cut-out which breaks the circuit in the event of too great a current being demanded, or in event of a transformer, for any reason, failing to give its proper E.M.F. and current coming back from the network. In addition, is a series field short-circuiting switch for each machine, one of these being fixed with each main transformer. This consists simply of a horse-shoe magnet wound with wire in series with the shunt circuit of the transformer, and when the armature is attracted the switch short-circuits the series winding on the transformer magnets.

At the central sub-station at the St. George's Hall, are fixed two batteries of accumulators, each of 57 K_{50} E.P.S. cells in lead boxes. For the purpose of charging these, a battery charging transformer is fixed at the central sub-station, and takes its primary current at 105 volts from the distributing network, giving an output at the secondary of 300 ampères at 35 volts. This being connected in series with the distributing network, makes a total of 140 volts for charging; the E.M.F. being regulated by means of a resistance in the primary circuit. The battery switchboard contains a slate panel fitted with two ammeters, two voltmeters, two throw-over switches for putting batteries to charge or discharge, two switches for taking batteries off circuit, two double-pole fuses, two six-way battery regulating switches, and one transformer starting and regulating switch.



Map.

by watching the ammeter, the current going down as the transformer gets up to speed, the 33-way switch is then turned round so as to take out the starting resistance, the single-pole switch at the central station is then closed, which causes sufficient current to pass round the magnet of the long range switch for it to attract its armature, and so close the circuit from the secondary of the transformers to the distributing network.

The regulation of the E.M.F. of the system is controlled from the central station by increasing the E.M.F. of the generators as the load comes on to allow for the drop in feeders and transformers.

Extra means of regulation for any differences there may be between the various transformers is carried out by inserting a resistance in the feeder circuits, this being put in or out as required by means of 33-way switches.

To take a transformer off circuit the reverse process is carried out, the secondary circuit being first opened by short-circuiting the pilot wires, and so operating the long range switch at the sub-station.

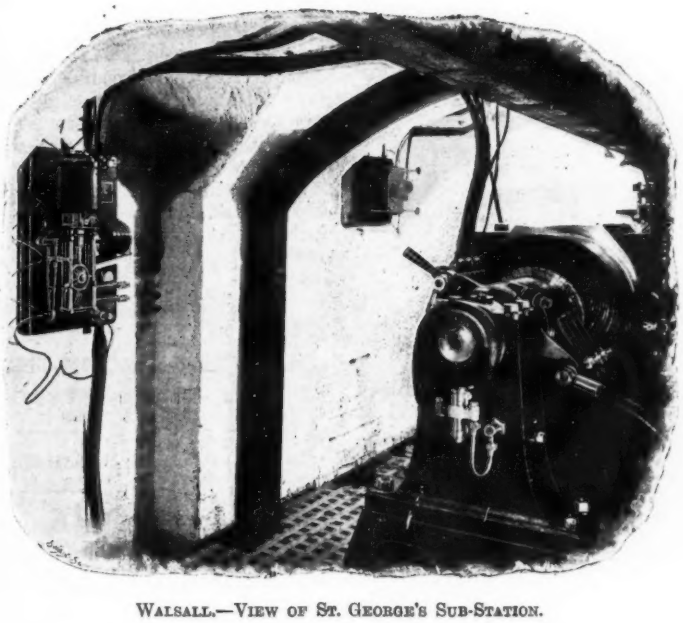
In the event of one of the cut-outs on the secondary of the transformers opening the circuit, the long range switch is left in a position that it can again be closed from the central station exactly in the same manner as when putting on circuit in the usual way.

There is a complete network of distributing mains throughout the area of supply. This is fed from three transformers situated at sub-stations, and also from the main battery. From the generating station to each transformer is run a pair of high tension feeders, and a pair of pilot wires are brought back from the feeding points to the central station.

The mains are of the concentric type, manufactured and laid by Callender's Bitumen Company. They are drawn into cast-iron pipes, the draw-boxes being constructed with blue Staffordshire bricks. The distributing network is [on the two-wire system, the mains being single conductor, lead sheathed and steel armoured. Network boxes of the Callender pattern are used at various points. A plan of the mains will give a clearer idea of their ramifications. Nearly 4,000 8-C.P. lamps are connected to the mains, and we understand that the prospects of the company are fairly good.

Mr. Alexander Wyllie, formerly with the Oxford Company, is the engineer to the station, while as we have already stated, Mr. Brown, of Walsall, has acted as consulting engineer for the Corporation.

The work has cost altogether about £16,000, the sum granted by the Local Government Board being £22,000.



Walsall.—View of St. George's Sub-Station.

EDUCATION OF MECHANICAL ENGINEERS.

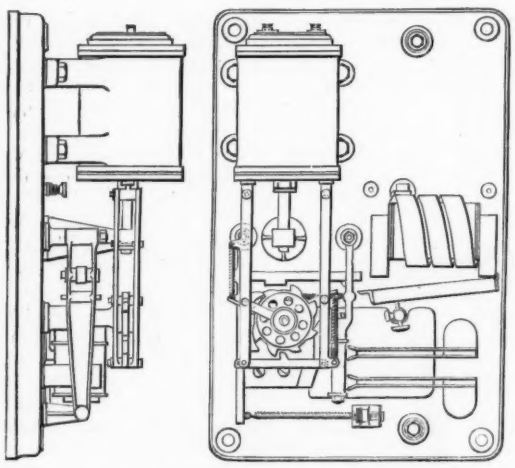
With the decline of the old system of apprenticeship, and the introduction of more scientific methods into practical work, there can be little doubt but that the technical school has stepped in and filled a want. The youth who could not gain an entrance to a good engineer's shop, has used the technical school, and whether they wish it or no, the manufacturing engineers whose greed has demanded heavy premiums from would-be apprentices, will, in the near future, have to look to the technical school for assistants. As is well known, there is a class of engineer whose aim in life seems to be to promote engineering works for the sake of the fees that go into their own pockets to the tune of many hundreds of pounds annually, though the manufacturing processes of which they have charge make little or no profit. A recent number of the *Engineering Magazine* contains a series of papers on the subject of engineering education from the pens of Prof. Thurston, Dr. Emery, and A. E. Outerbridge, jun. Naturally, Prof. Thurston lauds the engineering schools to an extent greater, perhaps, than is warranted by fact, but we think he is a little apt to overrate them in some respects.

"The equivalent of a few days' work makes him a good smith" is, we think, a statement that will be doubtfully received by experienced men who know what smith work really is. A few days' work cannot put a student into a state of proficiency at all approaching the skill of a country blacksmith, who has to cope with the varying calls made upon him, from horse-shoeing to the complete ironwork of a haymaker, such as we once remember to have seen taken up by such a man who had no tools beyond hammer and file, vice and anvil. But we know our Prof. Thurston, and can duly discount his glowing periods. The American Technical School cannot, when of the larger size, start for less than £200,000, or if affiliated to an existing university, for less that £100,000, and so on, while fees run from £40 down to nothing, the cost of living being from £20 to £40 annually, up to £600 or more, the students of this latter class usually proving failures. We are glad to see that Prof. Thurston is not opposed to, nay even endorses, a broad and liberal education even a classical one, as an effective reinforcement of the business side of life. Even when a man has forgotten his classics, and can scarce pick out one Greek letter from another, there will still remain to him something which is as much in evidence of his past as the polish on a sheet of glass is evidence of the use of emery and other substances no trace of which remains. Their work remains, however, and so it is with the refining influences which accompany the more liberal education. The special instruction of the engineering school is valuable indeed, but we would fully endorse the necessity of not narrowing down an engineer's education to the breadth of idea of the so-called utilitarian school.

Dr. Emery very wisely says that the success of the so called self-made man is not to be used as an excuse for neglecting the opportunities afforded to others in better circumstances. There are many men of fine natural ability who do undoubtedly make their mark. Of these, some have reached high positions by sheer luck, if such a term may be used, and after all is it not perfectly appropriate to describe the rapid rise of a man who has advanced by stepping simply into the shoes of predecessors who have died off or gone away at an abnormal rate: others have had sources of assistance not visible to the public, while others have succeeded by hard work, coupled to immense physical powers. But how many of equally capable minds have fallen out from physical disability. The self-made man who has succeeded, probably

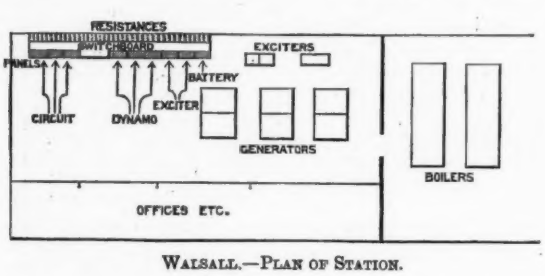
knows that his success is due to the bodily inheritance from a sound parentage as much as to his mental capacity. Then opportunity counts for much.

Dr. Emery would have the cause of study completed in early life in the technical school, if for no other reason than the desirableness of spending one's early life among gentlemen of education, an admission again of the value of a wider education than can be obtained otherwise. He would have students acquire dexterity with ordinary hand tools before studying machine tools, with which there is a danger of becoming infatuated. He deprecates the making of machinery to sell. This is not to be desired; the limit of time is too narrow to permit of it. He lays great weight on drawing as applied to actual design, but he considers the technical student to be deficient in this branch. After all,



Walsall.—Plan and Elevation of Long Range Switch.

the student must only attempt to learn principles; he cannot learn the details of engineering in all its many branches, so that it is useless to attempt to do so. Everything, now, is so specialised that actual experience in any branch is necessary to acquire a thorough insight into its details. One can understand the contempt felt by manufacturers and contractors generally when confronted with a Westminster specification on the most rigid of lines for the carrying on of work upon plans long since abandoned at twice the expense necessary for far better work. No recognition of commercial facts in the shape of standard dimensions, an entire absence of any appearance of knowledge of any changes in practice during the past quarter of a century, combine to pile up the cost of very much of the work now being done. Mr. Outerbridge states that he has hitherto contended that the aim of manual training should be the



Walsall.—Plan of Station.

production of bright young workmen, men, not officers. This, no doubt, was the idea of Whitworth in founding his scholarships, but we think he was disappointed in the results. We doubt if there are any Whitworth scholars now working at the "trade." Some have become professors, a few have succeeded in business, and others have used the advantages they no doubt obtained in order to get out of the stratum in which they were born, and have taken up with work of a quasi-mechanical nature only—becoming mere hangers on to the skirts of mechanical engineering. Mr. Outerbridge, however, thinks that the effect of the manual training schools of Philadelphia, which he describes, has been good. He would prolong the school life of a boy, and this, he believes, the manual school is bound to do. At present, few boys in America stay long enough at school to even pass to the grammar schools, and less than 1 per cent. reach to the grade of the high school. As to the apprentice question, America appears to be worse off than we are in this country, and it is a common saying that the American boy usually prefers to enter a dry goods store to dirtying himself in a workshop. But is it not natural that, so long as manual labour is, as a rule, remunerated at a low rate, there will not be much inducement for even those who like it to remain as workmen if they can receive better pay elsewhere.

So far as we can gather from this triple essay, the technical schools of America have not done anything much in producing skilled workmen. All the students who succeed seem to occupy good positions. Perhaps the less successful are not named; but the drift of the articles is certainly adverse to the success of the schools as manufactories of skilled workmen. But there can be no doubt that they are useful to the youth who cannot afford to pay a big premium, and who does not altogether relish standing six months on end at a bolt screwing machine or tapping nuts, the kind of work that he would probably be confronted with were he to go as an ordinary apprentice. Such a probation, especially when carried throughout an apprentice's whole time, is perhaps quite sufficient to explain the necessity of the old term of seven years' appenticeships; but so far as learning how to become even a workman, is it likely that any boy would ever become a good workman who could not learn to run a nut tapper as well in one month as in six. Ordinary apprentices would be easier to get, and of a superior class, too, if they were not compelled to waste so much time in the above and similar operations. The student in the technical school gets too little, perhaps, of this rough work, but he has some opportunity of picking up knowledge that is denied him in the workshop, unless specially favoured, and of sense sufficient not to abuse such favour.

MAGNETIC PROPERTIES OF IRON AND STEEL.

By J. A. KINGDON.

The extensive researches of Prof. Ewing into the magnetic properties of iron and other metals are well known to the electrical and scientific world. Commencing in 1881 with an examination of the magnetic properties of a twisted iron wire, and culminating in 1885 in a comprehensive investigation of the behaviour of magnetic bodies under the effects of varying and cyclic magnetising forces, as well as when subjected to mechanical stress and vibration, Prof. Ewing's results may well be regarded as a most valuable contribution to our knowledge of this subject. The recent award of a Royal Society's medal to Prof. Ewing for his researches in magnetism will no doubt, therefore, meet with general approval from members of the electrical profession.

Prof. Ewing is not, however, the only worker in this branch of science to whom electricians owe a debt of gratitude. It is now just 10 years since Drs. J. and E. Hopkinson discovered the true law of the magnetic circuit, and showed how to predict the behaviour of a dynamo from a knowledge of its dimensions, and of the magnetic properties of the iron employed in its construction. If a comparison be made between the technical literature on the subject of dynamo design of the present day with what was written before the Hopkinson law of the magnetic circuit was published, it will be clear that the knowledge of magnetism 10 years' ago was purely qualitative, and that quantitative magnetic calculations were practically unknown.

The value of iron and steel to the electrical engineer depends to a great extent on their magnetic properties. The electrical conductivity of a metal, that is, the ratio of the current to the effective electromotive force is practically a constant quantity. The corresponding magnetic property,

the permeability, or the ratio of the magnetic induction to the magnetising force, on the other hand, in the case of magnetic bodies, is very far from being constant. In the case of good soft-iron or mild-steel with a small percentage of carbon at ordinary temperatures, and under the action of a gradually increased magnetising force, the permeability is low initially, but increases very rapidly to a value of about 2,000. This, however, is by no means the limit of the value of the permeability, as Dr. Hopkinson has shown that when iron is heated to a temperature of 770° C., the permeability, under the action of low values of the magnetising force, attains the high value of 11,000. At this temperature, however, it is found that the induction cannot be raised to high values, and with a very slight increase of temperature the metal loses its permeability altogether, and becomes practically non-magnetic at 785° C.

At ordinary temperatures the highest value of permeability is attained in the case of wrought-iron at an induction of about 7,000 magnetic units per square centimetre. After this point the permeability becomes gradually less. Prof. Ewing has investigated the permeability of iron under very great magnetising forces. Under the enormous magnetising force of 24,500, an induction of 45,350 mags per sq. cm. was reached, so that the permeability was only 1·85, or little more than that of air.

In the design of dynamos the electrical engineer has to be content with much lower values of the magnetising force, in order to reduce the power required for excitation within reasonable limits. It is accordingly of importance to obtain magnetic material of a high permeability for values of induction ranging from 10,000 to say 16,000 mags per sq. cm. The advantages of wrought-iron over cast-iron in this respect are well known, and of late years steel, with a small percentage of carbon, has come into use for electro-magnets, it being found that the carbon, instead of lowering the permeability, increases it. In the massive yoke rings that support the revolving field magnets of the 5,000 H.P. Niagara alternators, tensile strength was even of even greater importance than magnetic permeability. These rings are made of nickel steel of a tensile strength of 36 tons per square inch, and their permeability is equal, if not superior, to that of the best wrought-iron, which of course would have a much lower tensile strength.

Prof. Ewing has devoted considerable attention to the study of the dissipation of energy that takes place when a magnetic body is subjected to magnetic reversals. When iron is magnetised, energy is absorbed, and remains stored up in the molecules of the metal, as long as the magnetic flux is retained. Upon the removal of the magnetising force part of this energy is given out in heat in the exciting circuit, but a considerable amount may still be retained in the metal, owing to the residual magnetism. If a demagnetising force is applied, so as to destroy the residual magnetism, it is found that the energy stored in the magnet is dissipated in heat. When iron is subjected to a periodic alternating magnetomotive force, the energy dissipated in heat may be found by a formula due to Mr. Steinmetz. If B is the maximum value of the induction, f the frequency of the exciting current, Q the cubic contents of the iron in cubic centimetres, the power wasted in heating from hysteresis $= Q\ \eta\ f\ B^{1\cdot6}\ 10^{-7}$ watts. The coefficient η depends partly on the chemical composition of the iron and partly on its hardness. For soft iron, η is ·002, and for hardened steel, ·025. It has been found that iron forming the core of a transformer has not a constant hysteresis coefficient, but that in some cases the value of the coefficient increases gradually during working. It has been thought that this increase of the hysteresis coefficient, and the accompanying decrease of permeability, may be due to some obscure magnetic action, but experiments made by Mr. Mordey go to prove that it is due to the rise in temperature to which the cores of transformers are subjected. It is, however quite possible that different qualities of iron or steel may have different properties in this respect.

In the manufacture of permanent magnets, it is of importance that the material employed should retain a large percentage of residual magnetic flux, rather than that it should be of very high permeability. The permanence of the magnetic properties of a piece of steel depends on the "coercive force" of the metal, that is, the reversed magnetising force which suffices to reduce the steel, after it has been strongly magnetised, to a non-magnetic state. Dr. Hopkinson, who has given this definite meaning to the term, has found the coercive force of tungsten steel to be 51, while that of soft iron is only 1·6 C.G.S. units. As the magnetomotive force of a permanent magnet is obtained by multiplying its length in centimetres by its coercive force, it is clear that a high value of the coercive force, which very prejudicial in transformer iron, is in this case an advantage.

While tungsten has the property of greatly increasing the coercive force of a sample of steel, it is found that steel containing about 12 per cent. of manganese is perfectly non-magnetic. This is a result which might be expected, since manganese, in spite of its close resemblance to iron in chemical properties, is impermeable to magnetism. Besides iron, and some of its alloys and compounds, the only magnetic bodies are nickel and cobalt. The latter metal and cast-iron are nearly on an equality as regards permeability, but nickel is less magnetic. An alloy of iron containing 25 per cent. of nickel has been found by Dr. Hopkinson to have extremely peculiar properties as regards magnetism. At ordinary temperatures this alloy is non-magnetic, but if its temperature is reduced a little below the freezing point, it becomes magnetisable. It then retains its magnetic properties until it is heated to the critical temperature of 580°, when, like other varieties of iron, it becomes non-magnetic, but, unlike them, it does not regain its magnetic permeability until the temperature is again reduced below the freezing point. At ordinary temperatures, therefore, this alloy may be either magnetic or perfectly non-magnetic, according to the previous history of its temperature.

THE TRUE RESISTANCE OF THE ARC.

By SILVANUS P. THOMPSON.

Prof. Ayrton has corrected in your last issue my erroneous recollection of the still unpublished paper which he and Mr. Mather read in September, at Ipswich. Coming, as it did, at the end of a rather fatiguing sitting, it was only possible to carry away an imperfect recollection of Prof. Ayrton's discourse; and when, wishing to summarise its result as a note appended to my Cantor lecture, I endeavoured to draw upon my recollection, I transposed the issues. The main thing left in my mind was that of the two terms in the usual expression for the relations between voltage, length, resistance, and apparent counter-electromotive force. Prof. Ayrton had found one to be negative, and not being quite sure which, I took the one that is the less absurd, and wrote, "the extraordinary result was obtained, that the supposed back electromotive force is a negative quantity." But I was wrong. I ought to have taken the other alternative, and instead, have written, "the extraordinary result was obtained, that the true resistance of the arc is a negative quantity." For an error so gross, and involving such momentous issues, I most humbly apologise. Nor would I for one moment minimise the wrong I did to Prof. Ayrton in thus misinterpreting the discovery which he announced; it is much the most interesting discovery in electricity that has been made in our time.

But, before I deal with the discovery itself, I will clear away the subsidiary topic of the formula proposed in 1882 by Profs. Ayrton and Perry, and the approximative form of it which I used in comparing it with those of more recent observers. Now, Prof. Ayrton himself says this equation of 1882 merely helped its authors to fit a curve. Then let us go back to the curve itself which they gave. It is to the facts that it expresses, not to the empirical equation devised to fit it, that my criticism applied, when I said that "the diagram they gave, which corresponds to these figures, is to me entirely unintelligible, unless one supposes that, in 1882, the voltmeters employed measured the voltages nearly twice too high."

The curve, accurately copied from the original paper of Profs. Ayrton and Perry in the *Proceedings* of the Physical

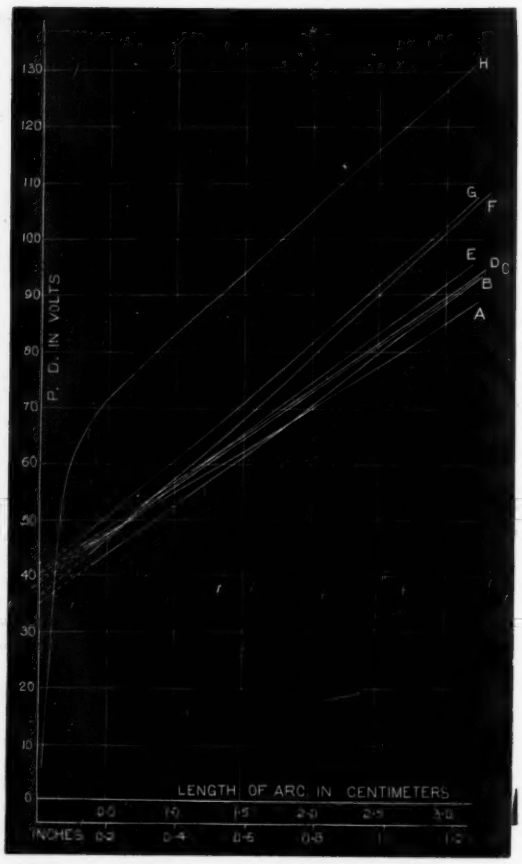
Society, is given in fig. 1, where it is marked H. It is a smooth curve, none of the actually plotted points being indicated. But that some of these were far from being on the line, is shown from the text, where in the preceding page it is stated that the same curve was *approximately* obtained for all currents; while on the next previous page it appears that, using one particular distance between the carbons (not stated), the volts varied from 28 to 30 volts on increasing the current in the proportion of 1 to 3. Examination of the curve will show that for all lengths of arc from 0·2 to 1·2 inch, it has the form of a beautifully straight line, pointing down toward the value 63 on the scale of volts; and that for all intermediate values between 0·2 and 1·2 inches —that is, over five-sixths of the range given—the volts rise with perfect regularity at the rate of 55 volts per inch, being about 73 volts at 0·2 inch and 128 at 1·2 inches. This great regularity justifies the proceeding of writing as a sufficient approximation for the working part of the curve,

$$v = 63 + 2{\cdot}1\ l,$$

where l is the length in millimetres; or

$$v = 63 + 55\ a,$$

where a is the length in inches. This is indeed the equation given by Profs. Ayrton and Perry, shorn of the correcting negative term, $-\ 63 \times 10^{-10\,a}$, which does not make as much as 1 volt difference for any length of arc greater than 0·179 inch.



A, Duncan and Rowland, 1892.
B, Peukert, 1895.
C, Frölich, 1883.
D, Luggin, 1887.
E, Cross and Shepard (mean), 1886.
F, Nebel (mean), 1887.
G, Uppenborn, 1888.
H Ayrton and Perry, 1892.

Fig. 1.

It will be seen by the comparison afforded in the Table, that this approximate formula gives values much more near the facts as stated in the curve than does the new formula of Mrs. Ayrton, for which such great accuracy has been (and not unjustly) claimed. The maximum and minimum values as calculated are those obtained by inserting respectively the values of 5·5 amperes and 10·4 amperes, between which the currents are stated to have varied.

Table.

Length of arc a, in inches.	Potential difference across the arc, in volts.			
	Calculated by Mrs. Ayrton's formula.		Calculated by formula as $63 + 55\ a$.	Actual points on A and P curve, 1882.
	Amp. = 5·5.	Amp. = 10·4.		
0·2	61·27	55·69	74	73
0·4	81·54	71·36	85	85
0·6	101·81	87·05	96	96
0·8	122·08	102·73	107	107
1·0	142·16	118·42	118	118
1·2	162·62	134·11	129	129

What possible objection can Prof. Ayrton have to my using a formula which fits his curve with such astonishing accuracy over the five-sixths of its range, and only fails for those very short lengths where the arc is unstable?

Upon the same diagram (fig. 1) and to the same scale, are plotted out other curves relating to the observations of more recent investigators. It will be seen that they exhibit a general sort of agreement with one another. The mean value as deduced from Cross and Shepard's results, plotted as curve E, may be taken as a fair sample. They all agree in the main feature of pointing back toward an initial value on the volt-line a little below 40 volts. The dotted parts relate, of course, to the unstable state which, with very short arcs, causes the volts to drop below the normal line so soon as hissing begins. The Ayrton and Perry curve gives no indication of the point at which instability was entered upon. It would, therefore, be unkind to attach any

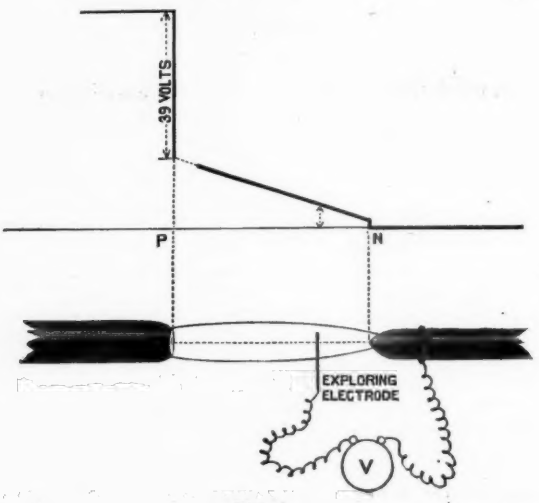


Fig. 2.

importance to the part of the curve within the value of a quarter of a centimetre, though now it is possible to get normal curves for arcs of a less length. The comparison leaves the matter pretty much where it was before. Why the Ayrton and Perry curve should point back to 63 volts, when everyone else's curve points back to about 39, or less, and why it should for an equal length of arc stand from 25 to 35 volts higher than all the more recent curves, are still to me "entirely unintelligible," unless there was something wrong with the voltmeters of the year 1882. I have looked in vain in Prof. Ayrton's letter for any hint of any other explanation.

Let us now return to the general question as to what facts are represented by the curves, and by the equations used to express them. The common expression for the potential difference, v, between the electrodes of the arc in terms of its length, l, namely:

$$v = a + b\ l,$$

has been found true for steady arcs over considerable ranges of length, a and b being constants, however, only for given values of current. If a given value of current is prescribed, the more detailed formulæ given by Mrs. Ayrton and by

myself both reduce to this simple and undisputed form. It holds good just so far as the arc remains stable and normal. It ceases to be true for lengths of arc less than about 1 millimetre, for that arc is unstable, and hisses. No evidence has yet been produced to show that if a stable arc could be maintained of a lesser length, the formula would not still hold good. What, then, does it mean? If the two terms have separately any meaning at all, they mean that the voltage of the arc consists of a fixed part, independent of the length of the arc, and another part which is proportional to the length. The former resembles the electromotive force which is found in accumulators and in motors running at a given speed to oppose the current, and may be correctly regarded as a back electromotive force. The latter resembles the electromotive force which is needed in any cylindrical conductor to drive a given current through it, being proportional to its length. Hence in saying that over the whole range of length of the normal arc the arc acts as though (to a given current) it offered a fixed back electromotive force of about 39 volts, and a true resistance proportional to its length, one violates no principle of physical or logical significance. There is no illegitimate passing beyond the bounds of logical inference, no extra-polating. Taking the Ayrton and Perry curve of 1882 as being correct, and not going outside the range of 0·2 to 1·22 inches (*i.e.*, about 0·5 to 3 centimetres), it is undeniable that it represents an arc as acting as if it offered a fixed back electromotive force of 63 volts, and, in

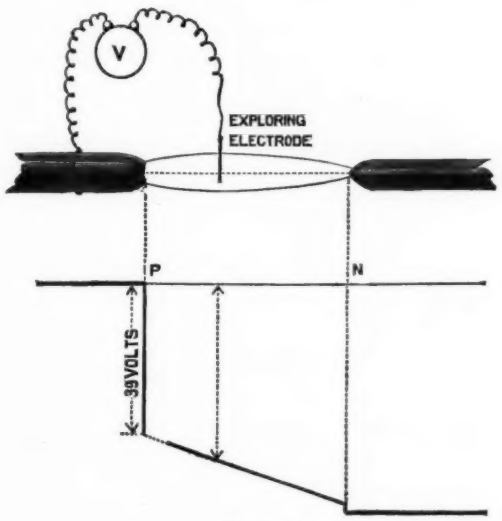


Fig. 3.

addition, a true resistance which is proportional to its length. If I were to do what I understand Prof. Ayrton to accuse me of doing, namely, say that this equation or curve will give me information about infinitely short arcs, I can only say that such an extrapolation would undoubtedly carry one outside the range of normal working, and land one in the region where hissing is set up. As for the ingenious series of algebraic puzzles which Prof. Ayrton has set me to show that v may be anything you like when l is reduced to zero, I will only say that I don't want to reduce l to zero. I want to find out how much, and what, the fixed part of v is when l is not zero. His puzzles do not throw any light on the facts. I am aware that it has been proposed to explain the existence of the fixed term in the formula for v in another way, namely, by supposing that there is a "transitional resistance" at the crater, a resistance which does not obey the usual rule of being independent of the current, but, for some reason or other, varies inversely as the current, so that the product of it into the current (*i.e.*, the volts required to send the current through it), is a constant value. I discussed this suggestion, indeed, in my Cantor lectures, and gave my reasons for preferring the other mode of regarding the facts.

But there is another, and equally important sense, in which the general formula:

$$v = a + b\,l,$$

is true for arcs (fed with a given current) beside that already pointed out. So far above, and in the whole of Prof. Ayrton's letter, the formula is treated as if it merely related to an arc of which the length was being altered. It is, however, equally true to describe the values of the fall of potential at points taken at various distances along an arc of fixed length. I have several times described the experiment of exploring the arc with a third electrode and a voltmeter. This may be diagrammatically represented in fig. 2, where the arc is (for convenience of plotting) represented as laid on its side. As exploring electrode, a bit of carbon filament out of a glow lamp is used, and a voltmeter (preferably one of an electrostatic form) is connected to one electrode of the arc. If (as in fig. 2), we begin to explore at the negative pole, gradually pushing the explorer along from the negative pole toward the positive pole, we find the potential to rise regularly (with a slight uncertainty just close to the peak), along the arc. With a 10-ampere arc, the rise of potential will be about 2 (or, according to Mrs. Ayrton's formula, 3·12) volts per millimetre. This in the upper part of fig. 2 is represented by the line that rises regularly toward the left from N. The voltage continues to rise steadily all the way along the arc until points are reached close up to the crater surface—not infinitely near, but certainly within a millimetre, unless the exploring electrode sets the arc hissing, and spoils the experiment. If the arc is 7 millimetres long, the rise will be altogether about 20 volts at most; but if the explorer touches the positive crater, then suddenly the voltmeter jumps up about 39 or 40 volts more, showing that at the crater surface, or somewhere within that last millimetre close up to the crater surface, there is located a something of a wholly different nature from a simple resistance. Call it a back electromotive force, or a transitional resistance, or what you will, it is located there at the crater; and, whether the arc be long or short, provided it is not hissing, whatever it is, its value on the voltmeter is found to be a little under 40 volts.

Begin the exploration the other way, from the positive end, with the voltmeter connected to the positive carbon, as in fig. 3, and you will find that, with a steady arc, no matter how short the distance of the explorer from the crater surface, the potential will drop down at least 39 volts, or so, with a sudden fall, and from thence will gradually descend in a regular, gentle manner, as the explorer passes along the arc toward the negative pole. Both methods of procedure agree together, and they confirm the results deduced from experiments on arcs of different lengths. They show, beyond all question, that the arc itself possesses a true resistance, causing a gradual fall of potential proportional to the length. They show, also, that an arc possesses something more than a mere ordinary resistance—a something which is definitely situated at, or close to, the crater surface, and causes a sudden drop in the voltage, opposes the current, and makes it less than it otherwise would be. The most elementary acquaintance with Ohm's law will show that anything which so affects a current as to make it less than otherwise it would be, must be one of two things. It is either a back electromotive force or else a resistance; there is no other alternative. But there are two difficulties in the way of regarding it as a resistance: it is apparently a surface phenomenon, and, unlike any ordinary resistance, it varies inversely as the current flowing through it. To explain it by calling it a transitional resistance explains it only by offering something still more needing to be explained. On the whole, I prefer not to beg the question, but to say it acts as a back electromotive force, for which, indeed, some physical reason can be given.

But I am forgetting, in trying to stick close to the facts that are known, Prof. Ayrton's startling discovery. Using a method of testing which, so far, has been only verbally described (and the validity of which I have dared to doubt), he has come to the conclusion that (for solid carbons) the "*true* resistance of the arc must be a *negative* quantity." This is indeed a discovery. For the first time in the history of electricity we have a body, the resistance of which is less than nothing. How eager we shall be for particulars. How many negative ohms does a 10-ampere 7-millimetre long arc possess? Are the negative ohms distributed equally along its length, or are they crowded up at the crater surface? A negative resistance is of infinite interest owing to the new possibilities it opens out. What sort of a minus-one ohm can one take as a standard? If one applies an electromotive force of 10 volts to a resistance

of 2 minus-ohms (or shall I say to a resistance of — 2 ohms?) will it produce a current of 5 minus-amperes. A resistance such that it causes the current to flow in a direction opposite to the electromotive force is a most unexpected find. Since an ordinary or positive resistance is heated by the passage of the current, a negative resistance ought to be cooled; is the cooling in this case proportional to the square of the current? How very sad it was of me to express doubts—grave doubts—as to the validity of any method of testing which promises so rich and unexpected a harvest.

A PORTABLE ELECTRIC LIGHT PLANT.

The illustration shows a portable electric lighting plant recently supplied by Messrs. Clarke, Chapman & Co., of Gateshead-on-Tyne, for river navigation in India.

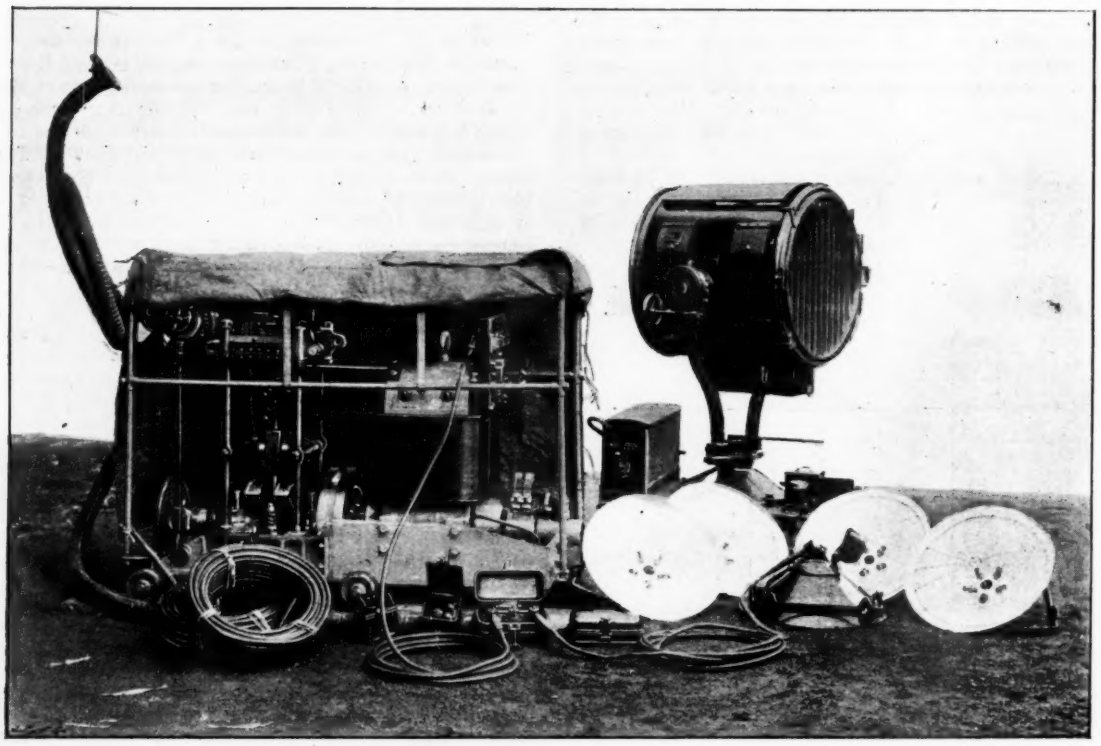
The engine is of the vertical single cylinder double acting type, having a cylinder $8\frac{1}{2}''$ diameter × $7''$ stroke. The dynamo is of the drum armature type, compound wound, and is capable of giving 12,000 watts at 65 volts pressure when running at 320 revolutions per minute.

The engine and dynamo are mounted on separate frames provided with wheels for running the plant into position on board, and are bolted together to form a complete bed; the dynamo is provided with a switchboard, and the necessary terminals and connections for the cables to projector and distribution boxes, which are shown in the foreground of the photograph. The distribution boxes in this case are intended to be placed upon flats lying alongside the steamer, and the cargo shades, each fitted with five 16 C.P. lamps, are connected to the distribution boxes.

These cargo shades are used in the embarking and disembarking of cargo. The projector, which is used for navigating the river, has a mirror 30 inches diameter, and is provided with a hand lamp and dispersion lens to give a flat beam. It is also mounted on a trolley provided with wheels, together with its resistance, and is run up to the bows of the ship when in use, the two lengths of cable being provided to reach from the dynamo to it. As will be seen, the engine is provided with two lengths of flexible steam pipe which are connected to the nearest exhaust pipes used for winches, &c.

The plant is provided with a tarpaulin cover, so that in bad weather it is all covered up, and is designed to run for long periods without attention.

Either engine or dynamo are designed to be slung separately or together, the aim of the designers being to obtain extreme lightness and portability.



Portable Electric Light Plant for River Navigation.

PREVENTABLE WASTES OF HEAT IN THE GENERATION AND USE OF STEAM.

Lecturing before the Franklin Institute on the above subject, Mr. W. Kent showed how great is the waste that often goes on, and his lecture may be read in conjunction with a paper by Dr. Emery, recently presented before the New York meeting of the Society of Mechanical Engineers. Incidentally referring to the loss that goes on in the coal pile by the so-called weathering of coal, a loss that affects the anthracites but very little, he avers that the principal waste takes place in the boiler furnace. Coal has four general constituents, namely, moisture, volatile matter, fixed carbon, and ash. The ash and moisture is all loss, unless we except the moisture which is held by some to be necessary to combustion, by the assistance it gives to the combinations in the furnace for the combustible constituents. It is possible the view is right, and that moisture is an essential to the necessary chemical equilibrium sought for in perfect combustion. Some of the volatile matter also is non-combustible, the nitrogen, for example, which, however, exists in very small quantity. It is shown in the usual way that two typical American coals—good anthracite and Pittsburgh bituminous, have a heat-giving power of 12,235 and 15,030 units, or, approximately, from 12 to 15 lbs. of water evaporated from and at 212°. The centennial tests showed from 10 to 12 lbs.

evaporation, with good anthracite in various boilers. Seeing that of a dozen picked boilers the last had but five-sixths the efficiency of the first, though all were under the best conditions for testing, and skilfully fired, it is inferred how great may be the losses in practice with badly set boilers carelessly tended; that their efficiency may fall much below five-sixths of the best results. Of 64 anthracite tests given by Mr. Barrus, two only gave results over 11½ lbs., and as five boilers in the centennial tests gave this figure, it is assumed to be obtainable with any well designed, properly set boiler, fired by a good man with good coal.

In bituminous tests six boilers out of 34 gave a result of over 12 lbs. evaporation, and this figure ought, said the lecturer, to be secured without difficulty. How enormous then must be the waste going on. Anthracite, or "hard" coal, should not be fired too thick for the draught to get through, nor so thin as to be overpowered by the draught. The thickness of fire should be such, that it is maintained, hot and bright by the draught, not dull and sluggish, which indicates imperfect combustion.

A fire may be too thin for the draught. Where such is the case, the air passes through in excess, and may so cool the fire as to turn it black—put it out. This is indicated by the formation of a dull patch in the fire, which, as described to us by an old locomotive fireman, spreads, and is very difficult to overcome. A hard coal fire may thus be practically blown out by the draught. Hence the need of finding, by observation, the proper thickness for each case, and sticking to it; also the need for sorting anthracite into sizes, so that the pieces of coal are much of the same size in a furnace. It is, however, in bituminous coal burning that real difficulties arise. The furnace is a gas producer, driving off gases often rapidly from the green fuel and at a low temperature. Chilled by the cold plates below ignition temperature they will not ignite, but produce smoke.

Mr. Kent recommends what has often been recommended in these columns, a different setting, so as to cause combustion to be carried on in a refractory furnace. He advises a large firebrick oven to be built in front of a boiler to serve as both gas producer and combustion chamber, and supplied with air heated in special flues. We know that such a furnace is smokeless and economical, but are also inclined to believe, as before stated, that probably smokeless effects can be secured by a partial application of the principle of refractoriness, seeing that already with water-cooled furnaces a near approach to smokelessness is already at times secured.

If tests be made of an inefficient boiler and its flue gases analysed, there will always be found an excess of air, that is, an excess beyond the acknowledged necessary amount of excess. Mere low temperature of the gases is no evidence, taken alone, of an efficient boiler; but there cannot be both low temperature and moderate air excess combined without economy. Even when the management of the fire is good, an excess of air may get in by way of bad brickwork and poorly fitted dampers. In a flue gas analysis, one must be sure of one's data, and, properly speaking, gas samples ought to be taken from both the chimney end of the flues, and from the furnace tube, before air leakage has had time to show itself. These points are not named by Mr. Kent, but we do cordially agree with him when he recommends refractory furnaces for bituminous coals, which give off unstable hydro-carbons, which will not burn properly unless maintained at fairly high temperatures. This is especially the case when the gases are given off quickly, and must not be cooled by cold plates below combustion temperature. Mr. Kent goes so far as to deny even the possibility of providing the conditions for smokelessness in an ordinary setting. We do not quite go so far as this, as we think it probable that, as above said, an addition to the ordinary furnace for a proportion of refractory lining might suffice to turn the critical point.

A great source of waste is insufficient heating surface. It is stated that 1 square foot for each 3 lbs. of water evaporated per hour will not be far wrong, though 1 foot to each 2 lbs. would at least do no harm. Or, again, what heating there is may be badly arranged. All the tubes may not be fairly in the circuit, and often the gas currents will short-circuit themselves. The one aim in boiler practice ought to be a high furnace temperature, a minimum of air, and a low chimney temperature. Bad firing is the great cause of excess of air. The grate cannot be left bare at any time without an enormous inrush of air worse than useless. Hence the mischief of any furnace above, shall we say, 5 feet in length. A grate of 6 or 7 feet is not within the compass of the average fireman. The rear end gets burned into holes, and where the fuel is thus burned away, cold air rushes in.

Leaking fittings, such as the water gauge taps or the blow out, are a fruitful source of waste. Inferior water gauge cocks, devoid of any mass or area of working parts, and big enough only to be held by thumb and finger when turned, are abominations. No water gauge handle should be less than can be gripped by the whole hand. And one of the most serious losses, because of the great heat capacity of steam, is a more or less constant action of the safety valves. In some places they seem to blow like a Cleveland all day long. For irregular work that sometimes causes this, the remedy is to have strong boilers and to work them at much below blow off pressure, allowing pressure to accumulate, while boilers with large water area allow of the waste being prevented by pumping in feed. In fact, we are told to have boilers of steady nature, and no doubt it is to their steadiness that the Lancashire and Cornish boilers owe so much of their success. Referring to chimney temperature, the lecturer considers that it is good practice when the gases are rejected at not more than 100° F. above the steam temperature. Assuming that this can be done, is it not an indication of one of the losses incidental to high pressure, and therefore high temperature steam? The flue temperature in good practice will, therefore, be 400° to 450°, but 500° is more common than 400°, and he has seen it over 1,000°. Thus even the best practice heats the ingoing air some 320°, and the maximum furnace temperature will scarcely exceed 2,400°, so that at least 13 to 16 per cent. of the total heat is lost up the chimney. How much then must depend on the use of a minimum of air which maintains a maximum of furnace temperature, a more active passage of heat through the plates, and a minimum velocity of flue gases. True, as stated, an economiser will save much of the waste heat, but if the temperature is air-diluted, even an economiser cannot utilise the heat. The heat is there, but heat is not temperature, and this ought to be borne in mind by anyone who looks to cover the errors of a fireman by means of a feed heater in the flues. This is not a mistake, however, into which Mr. Kent is ever likely to fall. Regarding steam pipe wastes these are serious. From an uncovered steam pipe, steam at 75 lbs. pressure radiates heat at a rate as follows:—

2-inch pipe, 1 horse-power per 132 feet of length.							
4	"	1	"	"	75	"	"
6	"	1	"	"	46	"	"
8	"	1	"	"	40	"	"
12	"	1	"	"	26	"	"

Yet 90 per cent. of this loss can be prevented by a suitable clothing. The worst of pipe clothers is, that they generally leave the flange exposed both on edge and sides, and also the bolts. This is a great mistake, and there ought to be some cover for these parts, for high pressures. Wrought iron pipe is now becoming more common. It has no flanges, and should be an economy. We once knew a Lancashire mill-owner who, when he had called in an expert to advise him as to coal economy, declined to cover his boiler crowns, junction valves, and large main steam pipes in the boiler house, on the ground that the room above the boilers was a yarn-drying store. He could not, himself, understand the mischief of wet steam in the engines and would do nothing. The remedy was too simple for him—we still have among us the Assyrian Naaman—and he even declined to take the steam pipe direct from the stove to the engine, and thereby cut out no less than nine bends, two enlargements and an exposed length across the mill yard.

In engine wastes, we have cylinder condensation always with us, and no emphasis need be laid on the waste of the over-loaded engine, or the still worse fault of under-loading. He sums up the expectation of water consumption in different classes of engine, as follows:—

Direct-acting pump	100 lbs. per H.P. and upward.			
High pressure throttling engine, slow speed	45	"	"	"
Modern high speed automatic cut-off	30	"	"	"
Compound high speed automatic cut-off	22	"	"	"
Corliss single high pressure ...	20	"	"	"
Corliss condensing	18	"	"	"
Corliss compound	14	"	"	"
Triple-expansion condensing ...	12½	"	"	"

The figures represent best practice, and the "*upward*," anything due to failure to come up to a good standard of work, design, or keep.

Triple-expansion will generally pay for powers above 500 H.P., and more than 10 hours per day service.

In an engine using 12½ lbs. of steam the efficiency is 18·68 per cent., or combined with a 75 per cent. boiler, a combined efficiency of 14·01 per cent., or about a seventh of the heat of the coal, the remaining six-sevenths, however, not being by any means all recoverable, these efficiencies being gross and having no reference to the thermo-dynamic principle, which teaches us that we cannot correctly term the steam engine so inefficient as it thus appears. It really is much more efficient when considered as a machine bounded by a natural law which limits the proportion of heat utilisable.

At present, 12½ lbs. of steam may be looked upon as a standard which, if attained, would immensely reduce the present consumption of coal in power generation.

CORRESPONDENCE.

The Institution of Electrical Engineers.

It does not appear to be disputed by any one, that owing partly to the rapid growth of electrical industries in several directions, and partly to progress in people's ideas as to the functions and scope of the representative professional institutions, the methods, organisation, and procedure of the Institute of Electrical Engineers have fallen somewhat behind the times, and are no longer adequate to represent properly either the aims or the requirements of the profession.

That under these circumstances there should be discontent and agitation is only natural. That in the onset this agitation should be obscure in its origin and indefinite in its objects almost absolutely follows when the diversity of the interests depending on electricity is considered.

For discontent and dissatisfaction to grow would be very undesirable, while there is every reason for trying to satisfy those aspirations of members which are legitimate, and for endeavouring to make the Institute as representative, useful, and up to date an organisation as possible.

There is, therefore, no reason for either haste or secrecy, nor for anticipation that the existing Council of the Institute would meet any well considered and influentially backed suggestions in other than a friendly spirit.

It is, therefore, most desirable that any schemes of reform or alteration should be brought forward openly and be debated carefully, and should be finally put forward only if there is a considerable body of opinion in favour of them.

Granted that a representative meeting of members were called, and that they, after discussion, appointed a committee to consider the matter, it may be asked what form the suggestions of that committee should take?

Before going into this it appears important to take into consideration what is the position of the Institute and its members at present.

It is obvious that the members are, firstly, divided into broad groups, comprising telegraphy, telephony, electric light and power, and electro-chemistry. Each of these groups again comprises consulting engineers, manufacturers, contractors, executive engineers, besides educationalists and some smaller sub-divisions.

No argument is needed to show that there is much diversity of aim and interest in the main groups alone, not to speak of their sub-divisions. It is also pretty clear that these groups will tend to differentiate still further in time. It is also manifest that all these groups of industries are increasing in importance and advancing at a rapid rate.

This heterogeneous mass of members is represented at present by a council consisting of 13 ex-officio past-presidents with full voting powers, 1 president, 4 vice-presidents, 12 full members of council, 3 associate members of council—total 33 voting members of council.

Of these thirty-three voting members, fourteen are perpetual and four nearly perpetual, so that the balance of voting power always lies with the perpetual members; besides this, the latter have all the moral advantage which continuity gives.

The three associate members, of course, do not count for much, their position being a semi-honorary one.

The real representation of the body of members, numbering 1,700, is therefore confined to the ordinary members of Council, who only amount to fourteen, and of whom, except in cases of vacancies, only three are elected annually. The new blood which can thus be introduced is only 10 per cent. annually, even if no members are asked to serve a second period, which is often the case.

When it is further recollected that out of the four places which is about the number vacant annually, and open to the introduction of new blood, places must be found for representatives of the army, navy, occasionally of the law, and sometimes of electrical finance, it needs no argument to show how ridiculously small must be the representation of that vast body of men who, not to include telephony and telegraphy, have been pouring into the electrical industry proper during the last ten or twelve years, at the rate of many hundreds a year.

With the present constitution, and at the present rate of progress, which bids fair to be maintained at any rate for some years, the representation of this great and increasingly influential body of men must become more and more inadequate, unless something is soon done to put matters on a more up to date footing.

The question then becomes what line these reforms should take?

This is evidently very debatable, but it seems so me that something on the lines of the following suggestions would meet the difficulty fairly.

In addition to the present Council, which might remain as it is, three permanent committees might be appointed, one to represent telegraphy and telephony, one for electric light and power, and one for electro-chemistry. Each of these committees should consist of abont six members, under the presidency of a senior member of Council or Vice-President. Three members of each committee might retire annually, and three new ones be elected annually by the society.

These three committees could make any recommendations they pleased to the Council through their president, and such recommendations might be in writing, and could be published in the *Journal* together with the Council's replies, favourable or otherwise; in which way members would have some idea of what was going on. These committees need have no executive power except through the Council, but they would be in much closer relations with the particular group they represented than the Council are now, and would know the requirements of their constituents much better, and as at least nine new men would be needed each year in addition to those now required, it would offer an opening for the infusion of sufficient new blood, while each branch of the electrical industry would feel that there was a body to look specially after their interests. The committees would also form an avenue to the Council.

The above is, of course, a mere outline, but it would appear as if, in some such way as sketched above, adequate representation of all the groups of members could be secured for some time to come, while the usefulness and progressiveness of the Institute would be much increased, without upsetting existing arrangements.

There are, it seems to me, a number of important and pressing questions which the strengthened Council could then deal with, and which would add immensely to the utility of the Institute if properly taken up, while its prestige, and its capacity for promoting the interests and convenience of members, would be much increased.

G. L. Addenbrooke.

P.S.—At the Royal Photographic Society, the allusion to which at the general meeting so amusingly excited Mr. Campbell Swinton's ire, great benefits have arisen from a scheme of affiliation, by which local and provincial societies are kept directly in touch with the senior institution.

If I rightly understand the feeling of the large section of members of the Institution who, with its best interests at heart, are of opinion that the time has now arrived when some changes should be carried into effect, their desires may be comprised under two principal heads.

They are anxious, firstly, that the constitution and the manner of election of the Council should be so altered as to render the Council more truly representative of those who are actually doing the electrical work of the present day, more in touch with their requirements, more conscious of their desires and aspirations, more amenable to their wishes.

Secondly, that the standard of qualification required for full membership of the Institution should be raised, so that such membership should be a real, and not as at present, a practically nominal distinction.

With a view to arriving at a satisfactory solution of these problems, I beg to submit for consideration the following suggestions, which are, of course, only in outline, and are capable in some cases of considerable modification in detail.

1. Some curtailment of the growing preponderance of power at present vested in the permanent members of the Council, as distinguished from the elective members.

2. An increase in the number of elective members of Council, so that all branches of the profession shall be more adequately represented.

3. A larger number of members of Council to retire annually, so as to allow of the introduction of more fresh blood every year.

4. Greater facilities to be given for country members serving on the Council, it being understood that such country members of Council need not give such constant attendance at the Council meetings as is expected of members resident in London.

5. A much longer interval of time to elapse between the publication of the Council's nominations for new members of the Council and the date on which the ballot is held.

6. The list of nominations to be published at least one month before the issue of the ballot papers.

7. The ordinary members to be given an opportunity of adding names to the Council's nomination list, and names so added by ordinary members to be printed on the official ballot papers in such a manner as to be indistinguishable from those nominated by the Council.

8. The evening devoted to the annual general meeting to be reserved entirely for the necessary formal business, and for discussion on any matters pertinent to the general affairs and welfare of the Institution.

9. Some alterations to be made in the constitution of the Institution whereby, for the future, no one shall be qualified for election as a full member who is not actively engaged as a practising electrical engineer or electrician, a new class being created, as in the case of the Institution of Civil Engineers, for those who desire to belong to the Institution, and whose association with the Institution may be of advantage to the latter, but who are not qualified for full membership.

None of the above suggestions can be said to be in any way revolutionary, one and all of them being taken from the regulations in force in other engineering societies older and more experienced than our own.

I believe that some changes in the direction indicated could not fail to be salutary, and would greatly increase the prestige, usefulness, and harmony of the Institution as a whole.

A. A. C. Swinton.

December 31st, 1895.

Fires at Electric Lighting Stations.

During the past year several serious fires have occurred at electric light and power stations. I have looked carefully through the reports but have failed to find any satisfactory cause given to account for the outbreak; it would be interesting to know if the cause is still unknown.

Most of the serious fires, I think, have originated in the accumulator room, as at Kensington and Birmingham; is it possible the gases evolved and not sufficiently exhausted by proper ventilation may, in a manner yet to be explained, become ignited?

In some electric light stations, are not the accumulator rooms used as a store for insulated cables and vulcanite goods? the former in large coils. Is it possible from tarred tape and gutta percha covering, closely packed, spontaneous combustion may result, or inflammable vapour be given off which a spark could ignite? An analysis of the air in these chambers would decide this.

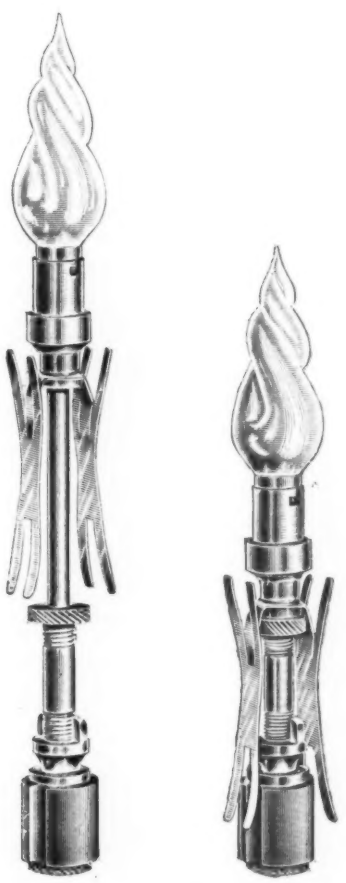
I think if a record could be kept of the number of fires caused in buildings through using gas earth, that water, or separate earth, would be insisted upon for telephone and similar purposes, as being more secure against atmospheric discharge fusing compo pipe and igniting gas.

Geo. N.

December 28th, 1895.

BUSINESS NOTICES, &c.

A New Electric Candle-Holder.—We illustrate an electric candle fitting, which has been patented and is being introduced by the General Electric Company, Limited. Hitherto candle fittings have been made to suit a certain length of glass or porcelain candle tube, but this new fitting is arranged to hold candle tubes of any length within a range of from about 3¾ to 6½ inches, the stalk being telescopic, and having a milled lock nut, so that a desired degree of tension may be adjusted prior to putting the tube in its place. A stamping with light spring claws is fixed under the lamp-holder, so that the eight points may, by fitting the interior of the tube, hold it centrally in position, relatively to the stalk, lamp-holder, and lamps. The base is formed of a plug of India-rubber surrounding the lower part of the telescopic stalk, and is longitudinally



grooved so as to afford greater resiliency when fitting it into the socket to which it may be adapted. We are informed that a tension nut with vertical wings, pressing a conical plug into it, enables it to be more securely held in position, since it is claimed that by tightening it upon the telescopic tube, it tends to increase the diameter of the plug. The two views illustrate the extreme range of the holder, the candle tube not being shown, and it is believed by the company that the new candle-holder will tend to popularise a style of electric lighting which has always been attractive for drawing room, salon and gallery illumination, but which it is stated has hitherto been somewhat neglected by reason of the difficulties experienced in adapting candles of varying lengths.

An Induction-overcoming (?) Telephone.—The tests described below were made between Baltimore and various other points on the Baltimore and Ohio Railway, in the United States, with the Brown loud-speaking telephone transmitter and the Collier-Marr receiver, the patents for which belong to the Single Wire Multiple Telephone Signal Company, Limited. The wires used were the

ordinary railway wires used for telegraphy, and the result is interesting as showing that the very great amount of induction present did not interfere with conversation. The same instruments were afterwards used on a railway wire between Chicago and Mesdville (500 miles) with perfect success. September 16th: Wire in service, 182 iron, gauge 9 (rather smaller than English standard gauge 11), to Washington, occupying poles carrying 28 wires, distance 41 miles; conversation carried on perfectly and easily at a distance of 10 feet from the receiver during a thunderstorm. September 17th: Test made on a single copper wire, gauge 12 (14 English standard), wire No. 40, from Baltimore to Washington Junction (28 other wires to Washington, and 10 beyond), distance 86·3 miles, during a heavy storm of lightning, very heavy induction; conversation easily carried on at a distance of several feet from the receiver. September 18th: Raining at Baltimore and all along the line; heavy thunderstorm between Baltimore and Cumberland.

First Test.—Iron wire, gauge 8 (10 English standard), Baltimore to Cumberland, 195·7 miles (10 to 28 wires along the route), earthed at each end. Cumberland could be heard by placing the ear close to the instrument; conversation carried on, but with difficulty, owing to storm.

Second Test.—Copper wire, gauge 12 (14 English standard), earthed at both ends, perfectly intelligible speech, although induction very great; the effects of storm quite apparent.

Third Test.—Copper wires, gauge 12 (14 English standard), forming a metallic circuit, Baltimore to Cumberland, distance 195·7 miles; speech perfect, and could be heard from 5 to 10 feet away from the receiver. The lines used, besides being parallel or on the same poles, are parallel and in proximity to electric light and street railway wires at different points along the line. Tests were made when these wires were all in operation, and when the wires on same set of poles were being used for multiplex and other telegraphic uses; though the induction was very great, the speech was so clear that when one stood a few feet away from the receiver, noises due to induction were not audible.

[We insert the above at the request of the Secretary of the Single Wire Multiple Telephone Signal Company, but we fail to see anything remarkable in the results obtained. There is nothing to prove that satisfactory results would not have been obtained with other standard forms of instrument. To make trials of the kind of real value, standard instruments ought to have been set up along with the (so-called) induction-overcoming telephone, and the two used alternately, and the relative effects noted. The tests made on September 16th through 41 miles of wire, *i.e.*, through a "K R" of about "1,000" were ridiculous; a telephone made by an amateur would speak well with such a feeble trial. The fact that a thunderstorm existed looks well for a "boom," but practically means very little. The same remarks apply almost equally to the experiments on the 17th and 18th. We do not suggest that the telephone in question is not a good one—nay, it may be an exceptionally good one—but much more systematic tests than those mentioned are required to prove the case.—EDS. ELEC. REV.]

Business Announcement.—Messrs. Heaton & Co., electrical engineers, of Salford, have engaged the services of Mr. Thomas Bell, late with the General Electric Company, as their representative.

Calendars and Price Lists.—The Chloride Electrical Storage Syndicate, Limited, has sent us a large framed calendar, which is very tastefully designed, and printed in a variety of colours. The size of the frame is 15 inches by 20 inches.

A catalogue of general and engineers' steel tools and toy tools has just been issued by Messrs. Wynn, Timmins & Co., Limited. There is a good assortment of tool-chests, chisels, wrenches, ratchets, cramps, stocks and dies, spanners, as well as a variety of small articles for domestic use. The catalogue is well illustrated.

All manufacturing and engineering firms doing business with India should have in their possession a copy of the "Indian and Eastern Engineer Diary" for 1896, which has just been published by the Indian Engineering Company, Limited, of 28, Victoria Street, S.W. There is an immense amount of general business information, which cannot fail to commend itself to users of the diary.

From the Commercial Cable Company we have, as usual, received a neat and handy calendar for 1896, with a separate sheet for each week.

The Electrical Power Storage Company has also, in accordance with its usual custom, prepared a very useful office blotting-pad, with a gummed slip along the top edge for each month of the year. In addition to a quantity of details regarding the E.P.S. accumulators, there is a handy diary, interleaved with blotting; also the usual postal and other information.

A nice sized calendar, with a separate sheet for each month, has been sent to us by Messrs. Croggon & Co., Limited.

We have also received a "Date Remembrancer" for 1896, with a separate sheet for each month, from Messrs. W. H. Willcox & Co.

From Messrs. Laurence, Scott & Co., Limited, we have received a pocket list of their dynamos and motors for continuous current. There is a lot of tabulated detail *re* wires and cables, also some "Useful Notes." Dynamos for the Scott-Sisling system and the "Norwich Shiplighters," are also dealt with.

Messrs. Weyman & Hitchcock, Limited, of Cheltenham, have issued a catalogue (December, 1895) of the "Trusty" oil engine, giving a general description, specification, plan of working, tabulated details and prices, as well as a number of excellent illustrations.

Change of Address.—Messrs. Dorman & Smith announce that they have found it necessary to remove their London branch to more commodious premises at 94, Charing Cross Road, W.C., where they have opened offices, show rooms and stores, which will be in charge of Mr. A. H. Dorman.

Messrs. F. Wiggins & Sons, mica merchants, announce, owing to the great increase of business, they have purchased No. 103, Minories, and that during the demolition and rebuilding of that and their old house, No. 102, Minories, they have taken temporary premises at 62 and 63, Minories (opposite), where for the next 12 months all communications should be addressed, or to their other establishment, 10, Tower Hill, London.

Bankruptcy Proceedings.—January 16th, at 11.30 a.m., has been fixed for the hearing at Bankruptcy Buildings, Carey Street, W.C., of the application for discharge by Walter Andreae, electrical engineer, of Fulham and Vauxhall Bridge Road, whose case we have already noticed in these columns.

The adjourned public examination of the directors of the New British Electric Light Installation Contractors, Limited, was resumed on 18th ult. at the Worcester County Court, before the Judge (Sir Richard Harington). On account of the absence of Mr. Duce, whom the Official Receiver wished to examine, the adjourned examination was fixed for January 22nd.

Dissolutions of Partnerships.—The partnership heretofore subsisting between W. Baker, E. L. Hill, A. E. Ward and A. Manock, carrying on business as upholsterers, electrical engineers, &c., at Oxford, under the style of Baker, Hill & Co., has been dissolved, so far as regards the said Edmund Lewin Hill, by mutual consent, as and from September 29th, 1895.

Also P. J. McKinlay and H. K. Smith, carrying on business as iron merchants and electrical engineers at 24, Upper Thames Street, London, under the style or firm of McKinlay, King Smith & Co., have dissolved partnership by mutual consent, as and from December 31st, 1895. All debts will be attended to by H. K. Smith.

Liquidation Notices.—A general meeting of the members of the Electric Lighting and General Development Syndicate, Limited, will be held at rooms 401-2 at 11, Queen Victoria Street, E.C., on Saturday, January 25th, to receive the liquidators' report, showing how the winding-up has been conducted, the property disposed of, &c.

The *London Gazette* contains an official notice to the effect that at a meeting of the company held on December 16th, 1895, at Winchester House, it was resolved to wind-up the company, Mr. W. P. Eldrid, of 11, Old Jewry Chambers, E.C., being appointed liquidator.

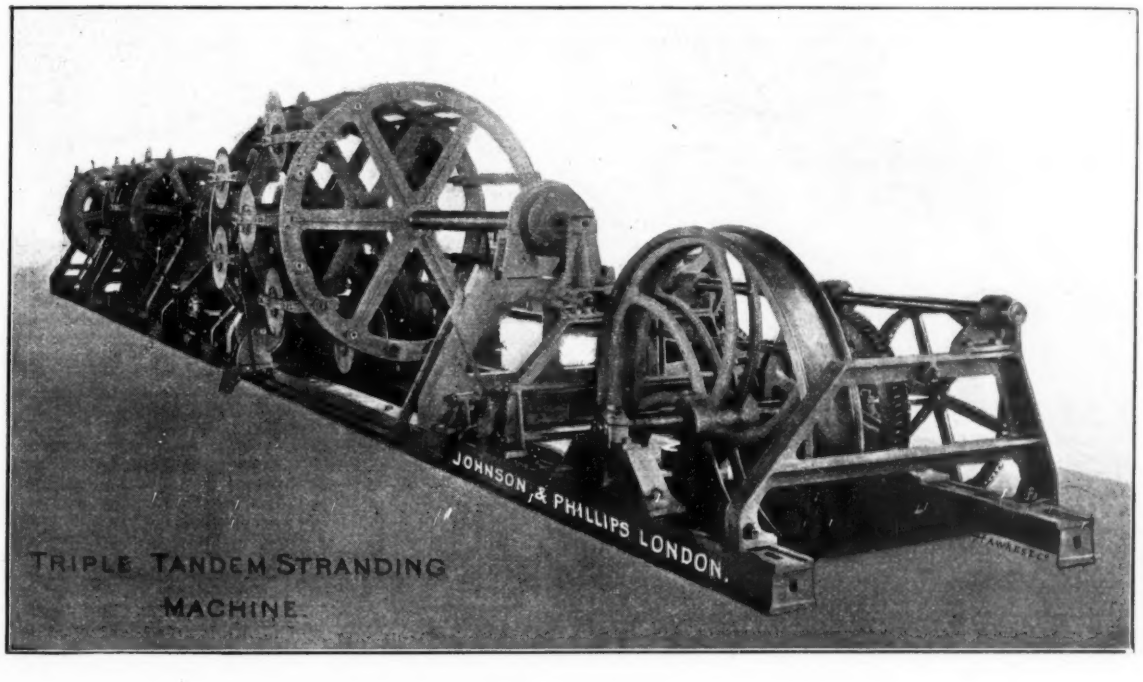
Scrubbing Machine.—From the Scrubbing Machine Syndicate we have received a pamphlet relating to a capital invention of Messrs. Gee's, of Middlesbrough, which is a portable machine for washing, scrubbing, and cleansing floors of factories, workshops, offices, &c., which has to be pushed along like the well-known carpet sweepers. A company is shortly to be formed for manufacturing and selling the machines. At present, the matter is in the hands of the Scrubbing Syndicate, Limited.

The Year 1895.—We have received the following reports of work carried out during the past year:—

Messrs. Doulton & Co. report that the use of their stoneware underground electrical conduits for new schemes and for extensions throughout the country has considerably increased. During the year these conduits have been laid for high pressure as well as for low pressure schemes, notably at Bedford, Portsmouth, Sunderland, Edinburgh, Chelmsford, Preston, Stafford, Oswestry, &c., and several of the London supply companies have adopted them as a standard system. Conduits of several types and accessories are supplied to meet the varied requirements of electrical supply, and these are described in the firm's new catalogue of this branch of their business. Notwithstanding that bare copper systems are regarded in some quarters with disfavour, Messrs. Doulton, who have supplied a large proportion of the insulators which have been used in existing bare copper schemes, remark that there has been hardly an apparent diminution in the demand for such insulators for new work by engineers who have had large practical experience of the use of such systems. Plant for the softening and purification of water for boilers, and for manufacturing purposes, is a special branch of Messrs. Doulton's business, and among the contracts they have executed during the past year, is one for complete plant for water softening at the St. Pancras new electric light station, which was mentioned in our description of those works. The firm have been busy at their London and Staffordshire works with orders for insulators for telegraph, telephone and electric traction purposes, as well as for battery jars, porous cells, plumbago crucibles, and the numerous other of their productions used in the various branches of electrical industry.

The Electric Construction Company, Limited, reports an unprecedented amount of work during the past year. Inquiries and orders for all classes of machinery have been very numerous. Great progress has been made in the design and efficiency of their specialities in dynamos, motors, continuous current transformers, alternators and converters, arc lamps, switches, &c. New catalogues have been issued and better prices prevail. Among special contracts may be enumerated a supply of generating plant for the Corporations of Wolverhampton, Stafford, Manchester, and Halifax; the Liverpool, Birmingham, Chelsea, Oxford, Crystal Palace and Clerkenwell Electric Supply Companies, Vestry of St. Pancras, &c. The Madras Tramways have also been successfully put into operation. Work in hand includes 500 H.P. dynamo for the War Office, 300 kilowatt steam alternator for Halifax, motor equipments for the Liverpool Overhead Railway extension, the electrical equipment of Hartlepool Tramways, and other important orders representing at least six months' work. Important additions to the premises and machinery are being provided to cope with the increased business.

Triple Tandem Wire Stranding Machine.—Owing to the great strides now being made in electric lighting and transmission, cable making is becoming a most important industry, and a description of a large wire stranding machine which has just been completed by Messrs. Johnson & Phillips may be of interest to our readers. The machine in question, which has been built to the order of a large firm of wire manufacturers on the Continent, is what is termed a triple tandem machine, and as the name implies, consists really of three separate machines arranged "tandem." The first part is a 6-wire machine, the second a 12-wire, and the third an 18-wire machine. Each part is arranged so that it may be run in the reverse direction to that of its neighbour, and at a different speed, and thus form a 37-wire cable in one operation. The centre wire being led through the centre hollow shaft, the first part of the machine lays six wires round it forming a 7-wire cable, the second part lays 12 wires on this forming a 19-wire cable, and the third part lays 18 wires over all, making up the 37 wires. The machine will equally well make cables with a lesser number of single wires, or if a flexible cable is required, 37 strands made up of smaller wires could be used. The machine is also arranged that each part may be run in the same direction and at the same speed, and provision made for leading the wires from the first and second parts through the third, so that the whole of the 37 wires or any lesser number may be laid on a cable in one flake, as might be required in making a concentric cable. This also adapts the machine for making much larger cables. For instance, if the 37-wire cable is passed through the machine again and covered with 24 wires, a 61-wire cable is formed, this passed through again and covered with 30 wires, forms a 91-wire cable, and this in turn can be passed through and covered with 36 wires, making up a cable of 127 wires. The bobbins each hold about 3 cwt. of wire, and are suitable for all sizes up to No. 6, B.W.G. All twist is kept out of the wires during the operation of cabling, by means of the usual arrangement of cranks and eccentric rings. The ground space covered by the machine is 60 feet × 10 feet, and it is erected on a continuous cast-iron girder bed running along its whole length. As will be seen on looking at the illustration the draw drums are of large diameter, and they are driven by means of worm gearing, the speed being capable of considerable variation by means of change wheels to give the different lengths of "lay" for the wires. The various parts of the machine are driven from a shaft running its whole length near the floor level. A novel feature in this machine is that the three sections are driven by chain gearing, and the builders believe this is the first example for a machine of this sort, and they claim that it is much quieter working than the usual arrangement of spur wheel gearing, the rattle of which causes so much annoyance. Another feature is that the central hollow shaft, which carries the revolving part of the machine, are provided at each end with heads which run on adjustable anti-frictien rollers, and as the centre discs also run on similar rollers the machine requires comparatively little power to drive it. We understand that the machine is capable of making about three miles of cable per working day. Messrs. Johnson and Phillips have for some time been very busy in this department, and amongst other machines completed is one for the Postal Telegraphs, for making 7-wire gutta-percha cables interlaid with yarns, and the whole covered with compounded tape, in one operation.



ELECTRIC LIGHTING NOTES.

Ayr.—The opening ceremony in connection with the installation of the electric light has been definitely fixed to take place on Wednesday, January 8th, when Lord Kelvin will be present.

Australia.—At Kalgoorlie, Western Australia, an electric lighting concession has been granted by the Corporation to an English company, which proposes to light the town within a few months.

Bradwell.—Mr. John Hall has introduced the electric light into his workshops here. A water motor drives a small dynamo, from which electricity is conveyed to his shop some distance away.

Brighton.—The Council is trying to arrange a new agreement with the Brighton and Hove General Gas Company, which will allow it to dispense with gas in any of the lamps at a month's notice. The object is to utilise the electric mains where they are already laid.

Douglas (I.O.M.).—"Magister Monensis," in an article in the *Isle of Man Times*, discusses at some length the best course to be adopted *re* electric lighting. The writer thinks the Commissioners should have accepted the offer of the Electric Tramway Company, last year, to light the streets with electricity, instead of so promptly refusing it. He argues that it would be better in more ways than one to take supply from the Tramway Company, instead of the Commissioners going to the expense of laying down special plant.

Eccles.—A deputation interviewed the Town Council some days since regarding electric lighting. The consultation was followed by several hours' discussion. The question considered was whether the recommendation of the Electric Lighting Committee, that a contract be entered into with the Manchester Edison-Swan Company, and application made for borrowing £20,000. It was resolved, by 11 votes to 10, that nothing further be done until the matter has been referred to the ratepayers for their opinion, which will be taken by vote or ballot.

Edinburgh.—The Electric Lighting Committee on 24th ult. resolved to recommend that electric lamps be placed in certain streets to the number of 143, at a cost of £2,628.

London.—We understand that Wesley's Chapel, City Road, is to be lighted by electricity, and a bazaar is shortly to be held to raise sufficient funds.

Mile End.—The Guardians have, through a committee, made inquiries of other guardians *re* electric lighting, and from five candidates they have now selected Mr. Jenkinson as consulting electrician.

Mill Lighting.—Messrs. D. Gurteen & Sons have entered into a contract with Messrs. Crampton & Co., of Cambridge and Yarmouth, to introduce the electric light into the mat department at Chauntry Mills. The light will be generated by a dynamo driven by the present engine.

Newmarket.—At the meeting of the District Council on Monday it was resolved to object to the Provisional Order of the Newmarket Electric Light Company, on the ground that a new drainage scheme was shortly to be considered, the steam machinery necessary for which might be utilised by the council for the supply of electric light to the district.

Newcastle.—The electric light installation in the People's Palace was done by Messrs. Rowland Barnett & Co., a gas engine being used as the motive power.

The Newcastle-upon-Tyne Electric Lighting Company have just ordered from the Brush Electrical Engineering Company a 300-kw. Mordey alternator, making the sixth machine in this very successful station. This brings the total capacity of the station up to 900 kilowatts.

Complaints having been made of the bad lighting, a full survey is to be made on 7th inst.

Pretoria.—An absurd instance of littleness and jealousy is found in the decision of the Transvaal Government regarding the establishment of electric lighting in the town of Pretoria. The specification which has just been published, forbids the use of English made plant, and provides that only that manufactured on the Continent is to be adopted. There is, however, very little doubt that for private installation work in mines, &c., British electrical trade will hold its own in that part of the Dark Continent, as our frequent notices of the work in hand have shown. Were the British given to retaliation in such cases, they would probably find ample trading opportunity for rewarding this jealous move with interest.

Writing on the subject to the *Standard*, "One Who Knows" says the stipulation is not intended as an unfriendly act. He says further that the electric lighting of Pretoria, under Government management, has been in full operation for more than two years; but the original plant, which was sent from England, proved to be of very inferior quality, and is already worn out. "It is but natural, therefore, that the Government of Pretoria should get their new plant from some other country." It is a pity the writer did not see his way to disclose his identity. Perhaps it would then have been possible to ascertain what weight attaches to his statement. In the absence of further particulars we are disinclined to credit the truth of the assertions.

Since writing the above, we observe a reply to "One Who Knows" in yesterday's *Standard* from "The Contractors," who say that as the statements are not only incorrect, but very misleading, "we beg to point out that the plant is in perfect repair and eminently satisfactory, the engineer in charge of the lighting station having recently stated to one of our engineers, who has lately returned from South Africa, that no plant could run more satisfactorily than that under his charge. As regards the underground cables, which have caused some trouble, no blame can be attached to the makers, the only mistake being that a class of cable was chosen unsuited to the peculiar nature of the soil. We do not, therefore, see how the performance of the present plant, which has been running nearly four years, can be said to have given rise to the decision referred to. We do not suggest that any unfriendly act is meant by interdicting English plant, but only suppose that, as in other cases, influence has been brought to bear by some Continental firm in favour of their own plant to the exclusion of others." We are even more curious to know who is the anonymous "One Who Knows" *not*.

Queensland.—The Brush Electrical Engineering Company, Limited, has recently installed an electric lighting plant in the Brilliant Gold Mine in Queensland. The plant comprises a two-pole "Brush-Vienna" dynamo, capable of running about 100 16-C.P. lamps.

Sunderland.—The Corporation Highways Committee, on 27th ult., considered whether steam or gas power should be used for the further extension of the electric lighting system in the borough. It was decided to recommend the Council to purchase steam power in preference to gas.

Swansea.—The Swansea Corporation has declared, by a majority of 30 votes to seven, in favour of prosecuting in the next session of Parliament their triple-headed scheme for electric lighting, tramways and a dust destructor. Vigorous efforts were made by a deputation of ratepayers to avert this result, but they were unavailing.

Whitechapel.—The Board of Works has resolved not to adopt the suggestion made by the surveyor to the Commissioners of Sewers that four electric arc lamps be placed on the east side of Middlesex Street, which is within the Whitechapel district, the board to pay the cost of the lamps.

Widdrington.—At the Widdrington Mechanic's Institute eight electric lamps have been put into the billiard room, of 95 C.P. each.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Electric Motors.—The use of electric motors is likely to be extended by steps such as are being taken by the Aberdeen Gas and Electric Lighting Committee, who have invited makers of all kinds of electric motors to send specimens to be placed on exhibition.

Electric Traction in Germany.—Plans are being prepared for an electric tramway between Hamburg, Wilhelmsburg and Harburg. Permission has been granted for work to be commenced on the construction of an electric tramway between Barmen, Schwelm and Milspe. The construction of an electric tramway between Hanover, Sehnde and Haimar, has been decided upon. A project is being considered for the construction of an electric tramway between Wiesbaden and Mainz.

Electric Traction in France.—A demand has been made for a concession to establish and operate a system of electric tramways in the town of Cherbourg.

Motive Power in Foundries.—A few months ago, at the iron foundry of Messrs. R. Maclaren & Co., Glasgow, an interesting combination of power, generation, and distribution was set to work. A gas engine of 180 H.P., supplied with gas from an independent gas producer, drives a dynamo from which the electric current is distributed to motors in various parts of the work. These electric motors vary from three to 25 horse-power, and the coal consumption is the phenomenally small amount of about 1¼lb. of anthracite coal per hour per actual horse-power delivered by the motors at the points required.

Newcastle Tramways.—The British Thomson-Houston Company, Limited, has written to the Town Clerk of Newcastle, and sent a copy of the letter to the Councillors, offering to equip and work the Newcastle trams electrically. The offer is as follows:—(*a*) We will provide a perfectly equipped generating station and car sheds, with engineering and repair shops, on land to be provided by the Corporation. The steam and electrical plant to have a capacity, with one complete unit in reserve, of supplying 25 double deck motor cars and the car shed to have a capacity for 35 cars. We will relay the whole of the lines in your city proposed to be equipped for cable traction, as set forth in the report of the Town Improvement Committee of October 15th, with 76-lb. steel girder rails, electrically bonding the same, and laying all requisite feeders underground. The trolley wire would be carried overhead on steel posts, in a manner similar to that employed by us at Bristol and Dublin. The whole of this work to be carried out for a sum not exceeding £86,000. (*b*) We are then prepared to take a lease from the Corporation for 7, 14, or 21 years upon the following terms:—We supply at our own cost the requisite rolling stock, consisting of double deck motor cars, carrying 43 passengers, and, if necessary, double deck trail cars for use at times of extra pressure. The cars will be of the latest and best design, equipped with two GE 800 motors, and latest pattern of "K" controller, having a series parallel method of control, with electric brake combined. There will also be the usual hand-brake. The cars themselves would be well constructed, roomy, and elegantly finished off, both inside and out. They would, after dark, be lighted, both inside and on the upper deck, electrically, and the interior would be electrically heated in cold weather. The trail cars would be similar, but without the motive power. We would work the line as to fares, times and workmen's cars, in accordance with the proposals embodied in the report of the Town Improvement Committee of October 15th, 1895, with the addition that we would be prepared to run a Sunday service if desired. We would pay, by way of rental, 7 per cent. on the total sum to be arrived at by adding the cost and interest of the reconstruction, half the cost of widening Byker Bridge, and the proportion of the old debt applicable to this portion of the tramway system (less the value of old material), and 3 per cent. on the value of the land. The lines would then be worked to the best advantage, with the regulations as to fares, workmen's cars, &c., as set forth above; proper and carefully compiled books being kept at the office in Newcastle, and a half-yearly account of profit and loss being issued, and of the net profits therein shown, 15 per cent. to be payable to the Corporation. This would, we anticipate, be an annual profit to the Corporation in relief of the rates of something like £1,200 to start with, growing with the increase of the town and the increasing prosperity of the undertaking, and this without any risk to the Corporation. The books should be open for inspection by you or a chartered accountant on your behalf. As stated above, the lease would be for 17, 14, or 21 years, but the Corporation might have the option, at any time, of terminating the lease upon terms of purchasing the rolling stock, &c., belonging to us, the lessees, the price to be fixed by arbitration in the manner prescribed under the provisions of the Lands Clauses Consolidation Act. A proper and reasonable guarantee, by way of deposit or otherwise, would be given by us for the due fulfilment of the foregoing provisions of the lease. By this scheme the Corporation would undoubtedly possess a more flexible system than if traction by cables were adopted. It will be noticed that we have not included in our scheme the Gosforth and Jesmond lines, as these were not included in the original cable proposals, but we would point out that it would be a comparatively simple matter to extend the plant we offer, not only to these lines, but to extensions all over the city, which, we feel sure, are greatly needed, and many of these extensions would be remunerative from the start, while others would very shortly become so. On the cable system it would be necessary to put down other generating centres, whereas, with an electric system such as we propose, the whole could be operated from one power station, and that power station need not be centrally situated, as is necessarily the case with the cable system. It would, therefore, be possible to obtain cheaper land for the electric than for the cable system. With regard to the period required for the reconstruction of the whole system, inasmuch as the whole of the track will have to be relaid with good rails, instead of the present very light and worn-out metals, the work in the streets would take from six to nine months, but very little interference need take place with the existing horse traction during that period. The same time would be ample for the construction of the generating station and car sheds. We would

suggest that we be empowered to construct all the work possible before the expiry of the present lease, so that when it fell in we could work the traffic with the least possible inconvenience to the public, in co-operation with your Council, until the electrical equipment could be completed.

South Staffordshire Tramways.—It is stated that arrangements have been arrived at between the South Staffordshire Tramway Company and the Electric Construction Company, by which the electric cars will continue running until January 31st. This we learn is with a view to a permanent arrangement being made, and the mayor of Walsall, who acted as mediator between the two companies last year, has consented to meet their representatives again in order to assist them in arriving at a settlement.

TELEGRAPH AND TELEPHONE NOTES.

Brazil and the Western Brazilian Company's System.—The secretary of the Western Brazilian Company informs us that telegraphic advice has been received stating that the necessary authorisation for the purchase of this company's line has been continued by the Brazilian Chamber of Deputies and the Senate, and is again included in the Budget for the coming year.

Communication with the Transvaal.—It is much to be regretted that in the present critical condition of affairs, both political and financial, in the Transvaal, telegraph communication between Cape Town and Johannesburg should be interrupted. From the Money Market article of the *Times*, we learn that the cause of this interruption is not known. We are also informed that the cable between Aden and Zanzibar was again interrupted on December 24th. This cable was last repaired in October, after having been interrupted for about a month; on that occasion also we had to remark that a telegram from Zanzibar, giving particulars concerning the rising of the natives near Monbasa, was "delayed in transmission." It is very regrettable that these breakdowns should occur just at the time when a reliable telegraph service is of the greatest importance, and when it might justify the extent to which it is subsidised by the Government. The Eastern and South African Company draws annually £60,000 subsidies.

According to the *Daily Telegraph*, a representative of the Press Association, upon making inquiries at the offices of the Eastern Telegraph Company, was informed that the delay was caused by the breaking of the cable between Aden and Zanzibar, on the East Coast route, which is the direct telegraph route to South Africa. So far as was known, the interruption had occurred near to Zanzibar, but a repairing vessel had been despatched, and it was anticipated that the usual communication would be speedily restored. So far as the informant knew, the delay was not due to any disturbance in the Transvaal itself. The interruption has thrown extra work on the West Coast route, where the arrangements at best do not afford facilities for great expedition. The London manager of a large commercial undertaking, having offices in Cape Town, Johannesburg, Pretoria, Buluwayo, and other places in South Africa, has expressed his belief that the wires had been cut between Cape Town and Johannesburg. He pointed out that the difficulty and anxiety of the situation were very much increased by the fact that the Eastern cable to South Africa is at the present time out of working order owing to some fault between Aden and Zanzibar. At this point the Eastern cable is particularly liable to fracture, and only a few months ago communication was interrupted for several weeks. The result at present is that all the messages between England and South Africa have to be sent by the Western route, which is unable to cope with the ordinary commercial telegrams. The break in the Eastern cable took place on Christmas Day. On Wednesday evening the Eastern Telegraph Company stated that at 10 o'clock telegraphic communication with Johannesburg was intact. Private messages were subject to serious delay, but it was due to the fact that the cable was occupied by long official despatches. The line between Cape Town and Johannesburg was working well.

French Colonies and French Cables.—The *Daily News* Paris correspondent says:—"The Select Committee of the Chamber on Petitions has referred to the Foreign Secretary a petition from the Colonial and Maritime Society, asking that all French colonies be united to France by French cables, the interest on capital cost being guaranteed by the French Government. It is pretty certain we shall soon witness a great extension of the French cable system over the world, and though the French are not aware of it, nothing could be better for British commerce than these fresh cabling facilities supplied at the expense of the French taxpayer. The committee having to select a reporter, chose, of all persons, M. François Deloncle. He draws a vivid picture of the horrors that would happen in case of war. The cables to French colonies are in English hands. 'We tremble,' says M. Deloncle, 'at the catastrophes that may arise from such a situation.' M. Deloncle recommends that an annuity of £600,000 sterling be guaranteed by the Chambers, being the interest on the initial outlay of £20,000,000 sterling necessary to emancipate French colonies from the bondage of British cables. M. Deloncle's intentions are none too friendly, yet he is engaged, unknown to himself, in a good work for all nations, including Great Britain. A purely French cable system would necessarily be in connection with England and most British colonies, and every important centre of commerce. We should probably benefit more than France out of a probably losing undertaking, in which we should not have sunk a penny."

Telegrams to Buenos Ayres.—The following circular to being sent out by the Western and Brazilian Telegraph Company, Limited (R. M. Cunningham, Secretary), and the Brazilian Submarine Telegraph Company, Limited (Richard Collett, Secretary):—"Our attention has been called to a pamphlet lately circulated amongst merchants, purporting to give from certain examples, selected from 26 days out of a whole year, a statement of the average time of transit of cable messages exchanged between London and the City of Buenos Ayres. The time is stated to be—By the direct route *via* Lisbon, Madeira and Brazil, about 7,280 miles, 108 minutes; by the Galveston route *via* United States, Mexico, Central America, Peru, Chili and Argentina, about 11,260 miles, 80 minutes. The undersigned have had the whole of the messages for all the dates in 1895 given by the pamphlet carefully examined, and find that the average time occupied by the messages sent over the Lisbon-Madeira route was 75 minutes only, and not 108, as incorrectly stated by the pamphlet. One statement being found so exceedingly inaccurate, you can form your own opinion as to what reliance can be placed upon the other, which is put forward for purposes that are manifest."

The Pacific Cable.—*Electricity* (New York), dated December 18th, 1895, states that the Pacific Cable Company has been incorporated at Albany, N.Y., with a capital of $100,000. The directors are Edmund L. Baylies, H. L. Leroy, C. D. Wetmore, G. A. Mills, Montclair, N.J.; I. M. Robertson and W. H. F. Hughes, of New York; and F. H. Allen, Pelham Manor, N.Y. Mr. Edmund Baylies has stated that the company would eventually increase its capital stock to $8,500,000 or $10,000,000, and that it intended to proceed with the laying of the cable as soon as the preliminary arrangements had been concluded. The plan contemplates a cable from San Francisco to Hawaii, and thence to Japan and other points on the Coast of Asia, with a branch to Australia. The business between New York and San Francisco will be done over leased wires. Steps have been taken to secure the concessions necessary for landing the cable in Hawaii and Japan.

The Message of the Telegraph.—Writing to the *Times* on Christmas Day, Mr. Robert Thos. Burr draws attention to the interesting fact that one of the first messages sent across the Atlantic after the completion of the ill-fated cable of 1858, was "Glory to God in the highest, on earth peace, goodwill towards men." Who can estimate the value of telegraphic communication in a crisis like that we have recently been through with the United States of America? The Atlantic cables of to-day have contributed in no small measure to the fulfilment of the famous message above quoted.

The Turkish Telegraphic System.—A commission has just been appointed by the Turkish Department of Posts and Telegraphs to examine the resolutions adopted at the Telegraphic Congress recently held in Paris, and to report as to the reforms which must be applied in the telegraphic system of Turkey.

Telephonic Communication in Iceland.—An American firm is reported to be erecting a telephone line between Reykjawik and Akureyri, in Iceland.

The Proposed Reduction of Rates to the East.—We learn that representations were recently renewed to the Postmaster-General on the subject of the high telegraph charges current for messages to the Far East. A letter written on behalf of the Duke of Norfolk, the Postmaster-General, stated that the Department had been repeatedly in communication with the companies and administrations concerned, but his grace regretted that he was not in a position to make a definite statement as to what had been done in the matter.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—March 1st. The Municipal Authorities of Brünn are inviting tenders for the establishment of a central station in the town for the generation and supply of electrical energy for lighting and power purposes, including that necessary for an electric tramway. Tenders to be sent to the Burgermeisteramt der Landeshauprstadt, Brünn, Austria.

Belgium.—January 15th, 1896. The Belgian Minister of War is inviting tenders for the contract for an installation of electric lighting in the new military school in the Avenue de la Renaissance in Brussels. Tenders to the Ministère de la Guerre, Brussels.

Brazil.—January 25th, 1896. The Minister of Industry of the State of Pernambuco is inviting schemes for the electric lighting of the town of Recife in that State.

Dublin.—January 8th. Tenders are wanted by Messrs. Arnott & Co., Limited, for the supply and erection of an electric light and power installation to new premises in Henry Street and Princes Street, Dublin. Details can be obtained from Mr. Geo. P. Beater, architect, 17, Lower Sackville Street, Dublin, on payment of £5 5s., which will be returned on receipt of a *bonâ fide* tender.

Germany.—January 10th. Tenders are being invited by the Hanover Direction of the Prussian State Railways for the supply of 1,100 telegraph poles. Tenders to be sent to the Königliche Eisenbahn Direction, Hanover, Germany.

Germany.—January 10th. Tenders are being invited by the Posen Direction of the Prussian State Railways for the supply of 90,000 arc lamp carbons. Tenders to be directed to the Königliche Eisenbahn Direction, St. Martin Strasse, 40, Posen, Germany.

London.—January 16th. The Vestry of St. Pancras is inviting tenders for wiring and fitting the Vestry Hall and offices for electric lighting. Details from the Electricity Department Offices, 57, Pratt Street, N.W.

Roumania.—January 15th. The municipal authorities of Ploesci, Roumania, are inviting tenders for the concession for lighting 46 of the principal streets of the town by electricity. Tenders to be sent to La Mairie, a Ploesci, Roumania.

Russia.—The Mayor of Charkow is prepared to receive tenders for the supply of steam and electrical engines for lighting, as well as apparatus and essential parts, necessary for an installation of electric lighting of 6,000 glow lamps and 500 arc lamps. Illustrated catalogues and price lists, with lowest quotations, to be sent to the Mayor of Charkow, Russia.

CLOSED.

Leyton.—The tenders which were submitted in connection with the Council's electric lighting installation were as follows:—

Buildings, machinery, foundations, &c.

	£	s.	d.
J. Holland, Wallwood Road, Leytonstone	2,976	0	0
H. R. Rons, Grays (*accepted*)	2,394	14	7
H. J. Carter, Grays	2,586	18	3

Gas producing plant.

Dowson Economic Gas and Power Company, Old Queen Street, S.W. (*accepted*)	854	14	0

Gas engines, piping, &c.

Crossley Bros.	1,342	14	0
Bilbie, Hobson & Co.	1,523	0	0
Wells Bros.	1,144	6	0
C. L. Ritchie (part contract)	174	0	0

Dynamos, switchboards, balancing transformers, wiring buildings, &c.

Holmes & Co., Portland Road, Newcastle-on-Tyne	1,726	10	0
Johnson & Phillips, Charlton, Kent	1,602	6	0
Thames Ironworks Company, Blackwall, E.	1,502	7	6
Brush Electrical Engineering Company	1,492	0	6
India Rubber, Gutta Percha, and Telegraph Works Company, Cannon Street, E.C.	1,479	8	2
Siemens Bros. & Co., Queen Anne's Gate, S.W.	1,478	7	0
Laurence, Scott & Co., Norwich	1,411	5	0
Wigston Electrical Engineering Company, Westminster	1,371	6	0
Crompton & Co., Mansion House Buildings, E.C.	1,339	12	0
Electric Construction Company, Wolverhampton (*accepted*)	1,330	7	2
Nalder, Harrison & Co., Bow Common, E.	1,153	0	6

Storage batteries and cable connections.

Headland Patent Storage Battery Company, Pall Mall, S.W.	1,113	0	0
Johnson & Phillips	1,092	10	0
Epstein Electric Accumulator Company, Victoria Street, S.W.	844	16	1
Conze & Simon, 52, Queen Victoria Street	818	16	0
Electrical Power Storage Company, Great Winchester Street, E.C.	754	5	10
A. B. Pescatore, Cross Street, Manchester (*accepted*)	748	4	6
Pritchetts & Gold, Soho Square	632	16	6

Mains.

India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown, E.	11,354	15	10
Henley's Telegraph Works Company, Martin's Lane, E.C.	10,286	11	10
Wigston Electrical Engineering Company	9,920	13	4
Glover & Co., Victoria Street, S.W.	9,646	5	1
British Insulated Wire Company, Prescot	9,380	15	5
Fowler-Waring Cable Company, Woolwich	9,295	16	2
Callender Bitumen Telegraph, &c., Company, Cannon Street	9,240	14	1
Siemens Bros. & Co. (*accepted*)	8,996	1	6

NOTES.

Our Central Station List.—In previous years we have usually published at this season a list of central stations in the United Kingdom. Last year, however, it was suggested that the list could be made much more complete if we deferred the publication of it till the end of March. We have decided to make the experiment, and hope that our efforts to make the statistics as complete as possible will be seconded by central station engineers.

Variation in Electrical Conductivity of Metallic Wires in Different Dielectrics.—This subject has recently been investigated by Mr. Fernando Sanford, and the results of his experiments given in the *Physical Review*. The wires tested were placed in the axis of a tube in which either liquids or gases could be introduced. It was found that the introduction of either liquids or gases into the tube reduced slightly, but sensibly, the resistance of the wire, and it is stated that the cause, whatever it may be, is certainly not due to any apparent conducting power in the medium itself, or to its power of radiating heat.

The Oldest Electrical Paper.—We have had a pamphlet sent us by an American contemporary, specially written to prove that it is more ancient than its fellows on that side of the Atlantic. We never thought it worth while to take such trouble on this side, although we have a certain contemporary in this country which makes a similar claim respecting its age. As a matter of fact, when the ELECTRICAL REVIEW was first published (as THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW) in 1872, there was no other electrical newspaper in this country in existence, nor of those now existing, with the exception of the official *Journal Telegraphique* of Berne, any in the world. We merely point out the inaccuracy, to put it mildly, but we attach no great importance to the matter, considering it far more desirable to be the most interesting and reliable than to be the most antique.

Rival Pacific Cables.—We learn that one of the most important duties Mr. Chamberlain will meet at the Colonial Office will be to deal with the Conference which will have to consider the new Pacific cable, to run *viâ* Canada to Australia. The Australian Governments have not yet selected their two representatives, owing, we believe, to some discussion as to what share New Zealand is to have in this representation. As to the representation of Great Britain, Mr. Chamberlain has a delicate task before him, as presumably England will take a leading position in this Conference. To select men whose knowledge and sympathies qualify them for this task, and who at the same time are not debarred from dealing with this question in the broad spirit which it requires, either by habits of official routine, or by any relations with some of the numerous telegraph companies interested, is not an easy matter. We learn that last month two distinct companies have been incorporated in the United States for the purpose of laying cables between California and the Hawaiian Islands, both of these are supported by well-known American capitalists; the ultimate object in one of these cases being to carry the cable as far as Japan. Amongst the supporters of these schemes we find such names as the following:—Mr. A. S. Hewitt (one of the leading citizens, and recently Mayor of New York), Messrs. D. O. Mills, G. M. Dodge, James J. Hill (of St. Paul, Minnesota), besides numerous others. As to the other project the directors are:—Messrs. E. L. Bayliss, H. L. Leroy, C. D. Wetmore, of New York, and F. H. Allen, of Pelham Manor, the latter is the son of the former American Minister to Hawaii. The meeting for the purposes of incorporation was held under the presidency of Mr. Scrysmer, who is known in connection with cables to South America. In view of the present relations between England and the United States we have little doubt that one or other of these companies will meet with strong support from the United States Government, apart from that which we understand is being privately afforded in England. We believe that some little time ago the Government of Hawaii was asked to endorse a scheme by which a cable laid from California to Hawaii would be continued by a French company as far as New Caledonia, thus giving direct communication between the United States and Australasia. This, however, is not at all a desirable conclusion to the succession of conferences which have taken place since 1888 between the various English colonies.

The Trolley Must Go.—*Electrical Engineering*, of New York, in its editorial notes, says:—"Of course it must go. What else was it devised for but to go, and to go quickly? It's a dutiful trolley, and it's going on about its own business, up one street and down another, out to the distant suburb and into the heart of the city. Going at a speed that enables working boys and girls to sleep half an hour longer in the morning; going so swiftly that the father may do a bit of housework after enjoying a hot supper; going so securely that the good mother need fear no harm shall befall her dear ones; going out into God's section of the great city, where the green grass and the birds and the fresh air may be enjoyed by many a family heretofore huddled in a single room or two in a down-town tenement. Oh! the trolley is going—going to regenerate the social conditions of thousands of working men and women. And may it continue to go on this mission until a better system can be devised for rapidly transporting the public."

Sulphuric Acids and Sulphates by Electrolysis.—If a celebrated dictum be true, namely, that a nation's commercial prosperity may be gauged by its output of sulphuric acid, then the manufacture of this substance by electrolytic means is of sufficient importance to claim the active attention of those who make electrolysis a speciality. Recently there have been two new departures in this direction, both by J. D. Darling, of Philadelphia. The first deals with the manufacture of the acid and bye-products; the second with a process for utilising what is known as nitre-cake, and other acid sulphates. In the manufacture of the acid, the mixture of nitrogen, peroxide and oxygen evolved when fused sodium or potassium nitrate is electrolysed, is used as a substitute for the nitric acid commonly employed. The decomposing vessel for the nitrate is of cast-iron, and is furnished below with a discharge pipe, controlled by a cock, and with a movable insulated cover with a pipe for conveying away the liberated gases. A supply pipe extends through the cover to a point near the bottom of the vessel. A series of cast-iron plates depend from the cover, connected to the positive pole of the source of electricity, the vessel itself being connected to the negative pole. The vessel is charged with sodium nitrate to about two-thirds its height, and the salt is kept in fusion. When the gases cease to pass, the current is switched to a second similar apparatus, and the first vessel is discharged and refilled. In the other process for the utilisation of nitre-cake and acid sulphates, the prevailing idea is to decompose an electrolyte containing a similar base to that of the sulphate with transference of that base to the sulphate. In treating nitre-cake, its solution is placed in the two outer compartments of a three-compartmented vessel, the partitions to which are porous, or partly so. The central compartment, which is charged with sodium chloride solution is closely covered, and provided with a feed orifice for admission of solid sodium chloride, and with a gas outlet for the chlorine produced. It contains a carbon electrode, forming the positive pole. The electrodes in the outer cells, constituting the negative pole, may be of sheet lead. Sodium chloride is added from time to time to the central cell, until the acid sulphate in the outer cells is neutralised, when the neutral salt is drawn off, filtered, and crystallised. The chlorine evolved during electrolysis can be used in any economical way; for example, for absorption by lime.

Lecture.—At Lovaine Hall, Newcastle, on Monday last, Mr. Philip Dawson lectured on "Electric Traction." In view of the consideration which cable traction has received lately at Newcastle, it is only fitting that the ratepayers should have the advantages of electric traction laid before them. There was a large attendance of ratepayers and others. The paper was illustrated by numerous lantern slides, showing the most recent English, Continental and American installations, and specially prepared for this lecture.

Appointment.—We learn that Mr. J. Hardie McLean, M.I.E.E., manager and engineer of the Oxford Electric Company, Limited, has been appointed Lecturer and Demonstrator of Electrical Engineering and Electric Lighting at the City Technical Schools, Oxford. A course of 20 lectures will be given during the session.

Personal.—We have great pleasure in congratulating Mr. Henry Charles Fischer, Controller of the Central Telegraph Department of the General Post Office, upon his appointment by Her Majesty, in the New Year honours, to be a Commander of the Most Distinguished Order of St. Michael and St. George.

Dinner.—An enjoyable evening was passed on New Year's eve, at the Holborn Restaurant, at a Dinner given by Mr. Paul, of Hatton Garden, to his employés.

The Institution of Civil Engineers.—A new edition of the list of members has just been published. The Institution has been in existence 78 years, and now numbers 6,794 members of all classes.

The Electrolytic Separation of Metals.—The persistence with which E. T. Smith and D. L. Wallace have been following up this subject during the past few years is praiseworthy to the highest degree, for it is by no means a particularly fascinating one to the average man, and the results when attained do not appeal to a very wide circle, though it is probable that they will yet have an important bearing on the gold industry. They have succeeded in separating completely from other metals, by using cold solutions of the double cyanides, cadmium, mercury, gold and silver; but from 12 to 14 hours was always required for the purpose. Smith working with Spencer have accelerated the deposition of both mercury and silver by heating the electrolyte to from 65° to 70° C. Following up this hint, Smith and Wallace now show that by working at a temperature of 65° C. mercury can be separated quantitatively from cadmium, zinc, nickel and cobalt in cyanide solution, containing a little free potassium cyanide by using a current density of from 0·02 to 0·08 (preferably 0·06) ampère per 100 square centimetres of electrode surface. Similarly, and at the same temperatures, gold can be separated from cobalt, arsenic, zinc and nickel, by a current of 0·1 ampère, or from copper by one of 0·07 ampère per 100 square centimetres of electrode surface. Silver can be separated from zinc, nickel and cobalt, as well as from copper and cadmium, by a current of 0·04 ampère per 100 square centimetres. The precipitates are stated by Smith and Wallace to have been pure, and the time required ranged from 3 to 3½ hours. There yet remains the problem of determining the conditions for the separation of silver from gold, and of mercury from gold and silver in cyanide solutions.

The Alpha Sign Lamp.—The Dickinson Electric Supply Company, 150, Nassau Street, New York city, has just placed upon the market an attractive novelty called the Alpha sign lamp, in which the novel feature consists in the shape of the lamp bulb, which is made of pressed glass in such a form that the top presents a flat surface on which a letter of the alphabet is etched. The background is filled in with black. The lamps are fitted with Westinghouse bases, which fit into sockets arranged in a line on a sign-board. All letters of the alphabet are supplied, and the words composing the sign may be changed as often as desired. The lamps can be made of a size to show letters 6 inches high. Our American namesake says that for show windows the Alpha sign lamps would seem to be especially adapted.

The Electrical Standardising, Testing and Training Institution.—Mr. James Swinburne will commence his usual course of lectures on "Dynamo and Transformer Construction" at the above Institution on Thursday, January 9th.

NEW COMPANIES REGISTERED.

Road Motor Association, Limited (46,338).—This company was registered on December 20th with a capital of £15,000, in £1 shares, to adopt two agreements, and to carry on business as newspaper proprietors, printers and publishers, motor makers, cycle manufacturers and dealers, electricians, machinists, &c. The subscribers (with one share each) are: J. W. H. Walch, 27, Fawnbrake Avenue, Herne Hill, clerk; T. G. Norris, Grace's Road, Peckham, clerk; J. P. Eldridge, 7, Brunswick Avenue, New Southgate, clerk; W. H. Rabson, 12, Percy Road, North Finchley, clerk; J. D. Newton Colin, Deep House, Hendon, clerk; E. R. Baines, 6, Whitgift Villas, Thornton Heath, clerk; G. G. Hay, Minet Gardens, Harlesden, clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first; remuneration, £100 each per annum, and £20 extra for the Chairman. Registered by Steadman & Co., 23, Old Broad Street, E.C.

Direct Electric Generator Syndicate, Limited (46,342).—This Company was registered on December 20th, with a capital of £100,000 in £1 shares, to enter into a certain agreement, and to carry on business as electricians, generators and suppliers of electricity, mechanical engineers, and makers of and dealers in electrical appliances. The subscribers (with one share each), are:—

A. J. Peton, 36, Buckingham Terrace, Edinburgh, major; H. Dobbin, 4, Balmuir Terrace, Putney, gentleman; S. Spill, 24, St. Ann's Villas, Royal Crescent, W., gentleman; J. Cooper, 8, Furnival's Inn, E.C., gentleman; F. L. Marshall, 22, Streatham Hill, S.W., gentleman; J. Lindsay, 32, Lupus Street, S.W., secretary; E. Hills, 11, Paulton Street, Chelsea, gentleman. The number of directors is not to be less than three nor more than 10; qualification £250; remuneration as the Company may decide. Registered by Ashurst and Co., 17, Throgmorton Avenue, E.C.

J. C. Howell & Co., Limited (46,346).—This company was registered on December 20th with a capital of £10,000 in £1 shares, to acquire and carry on the business of an electric light engineer, formerly carried on by J. C. Howell, of New Dock, Llanelly, and 24, Queen Victoria Street, E.C., and latterly, by J. C. Howell, Limited. The subscribers (with one share each) are:—A. G. Hudson, 42, Prince of Wales Road, Norwich, gentleman; S. Jordan, 13, Callow Street, Chelsea, gentleman; W. Eacott, 29, Powell Road, Clapton, gentleman; A. W. N. Stuart, 46, Ronald's Road, Highbury, accountant; T. F. Goddard, 9, Great St. Helen's, E.C., solicitor; W. F. Smart, 25, Spenser Road, Herne Hill, gentleman; C. T. Lissenden, 34, Alfred Street, Bermondsey, gentleman. The management is vested in J. C. Howell as sole managing director; remuneration, £800 per annum. Registered by Deacon & Co., 9, Great St. Helen's, E.C.

Lightning Express Railway Syndicate, Limited (46,366).—This company was registered on December 23rd with a capital of £100,000, in £1 shares, to acquire, develop and turn to account all inventions belonging to F. B. Behr in connection with lightning express or high speed railways, and in electric locomotives for the same, and certain licenses belonging to the Lartigue Railway Construction Company, Limited, and to enter into an agreement with F. B. Behr. The subscribers (with one share each) are:—L. Clow, 22, Austin Friars, E.C., stockbroker; C. G. Lindo, 2, West Street, Finsbury, solicitor; S. F. Foster, 48, Victoria Road, Kensington, lieut.-colonel; B. G. Lake, Priory, Orpington, Kent, solicitor; F. B. Behr, 6, Old Jewry, E.C., engineer; A. J. Sanderson, 66, St. James Street, S.W., financier; M. S. Russell, 39, Coleman Street, E.C., engineer. The number of directors is not to be less than three, nor more than seven. The subscribers are to appoint the first. Qualification £100; remuneration £1,000 per annum, divisible. Registered by Lindo & Co., 2, West Street, Finsbury, E.C.

Madeira Electric Lighting Company, Limited (46,371).—This company was registered on December 23rd with a capital of £20,000, in £1 shares, to enter into a certain agreement, and to acquire, develop, and turn to account a concession granted on May 22nd, 1895, for the lighting of the City of Funchal, in the Island of Madeira, by electricity. The subscribers (with one share each) are: T. H. H. Black, Glencairn, New Barnet, gentlemrn; J. Hicks, R.N., Moorings, Sevenoaks; C. C. Hood, 55, Spring Terrace, Richmond, agent; G. C. Edwards, 16, Tokenhouse Yard, E.C., clerk; H. Ullathorne, Charles Street, Bradford, electrical engineer; A. Hartley, Charles Street, Bradford; A. Steele, 109, Otley Road, Bradford, book-keeper. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification, one share. Registered by J. Twyford, 44, Finsbury Pavement, E.C.

Kamm's Zerograph Syndicate, Limited (46,406).—This Company was registered on December 27th with a capital of £12,000 in £1 shares, to enter into an agreement with Leo Kamm and to acquire, develop, turn to account, and deal with certain patents relating to telegraphy. The subscribers (with one share each), are:—L. Kamm, 1, Gresley Road, Hornsey, electrician; H. F. Hoveler, 97c, Queen Victoria Street, E.C., merchant; S. Reuschel, 112, Ivydale Road, S E., merchant; F. W. Von Limburg, 7, Mincing Lane, E.C., broker; C. Hess, 261, Burdett Road, E., manager; H. Hempel, 7, New Basinghall Street, E.C., merchant; J. W. T. Cutlan, 21, Station Parade, Hornsey, manufacturer. The number of directors is not to be less than two nor more than 20; qualification £100; remuneration £100 per annum divisible. Registered office, 133, Old Street, E.C.

CITY NOTES.

Londonderry Corporation Accounts.

Mr. John Christie, the electrical engineer to the Corporation, has sent us a copy of the electric lighting accounts for the year 1894-95, with a comparison with the previous year. It should be explained that street lighting by arc lamps only is undertaken by the Corporation. The figures are distinctly interesting, and ought to be closely studied by those interested in street lighting :—

Londonderry Corporation Electricity Works.

Works Started May 29th, 1894.

Loans sanctioned.	Amount borrowed.	Rate.
£18,942 ...	£18,942 ...	3½ per cent.

Financial Year of Corporation ends October 31st.

	1894.*	1894-95.†
Capital expended	£16,653	£18,942
Capacity of plant	180 kw.	180 kw.
Street lighting only	...	...
No. of 500-watt 2,000 N.C.P. ...	...	...
Arc lamps erected	170	170
Hours of lighting	1,104	2,838
Estimated units generated	93,872	241,302
Estimated units used per lamp ...	552	1,419
Works' costs per lamp		£12 9s.
Total costs per lamp		£20 12s. 9d.

* 1894 is for running May 29th to October 31st.
† 1894-95 is for running November 1st to October 31st.

No fixed charge made yet. Half-circuits extinguished at midnight. During winter months these are re-lighted again from 5.30 a.m. to daylight.

Costs of Production, Distribution, &c.

	1894. £	s.	d.	Cost per unit. d.	1894-5. £	s.	d.	Cost per unit. d.
Coal, &c.	265	5	6	·69	499	15	6	·50
Oils, waste, stores, &c. ...	78	17	6	·20	96	13	8	·09
Carbons	153	2	0	·39	317	5	3	·31
Wages	305	9	0	·78	660	15	4	·65
Repairs and maintenance...	12	8	10	·08	191	13	0	·19
Works' costs...	815	2	11	2·08	1,766	2	9	1·75
Rent, rates and taxes ...	63	11	0	·16	64	10	5	·06
Management, printing, insurance, sundries, &c. ...	174	2	8	·44	260	8	9	·25
Total Costs	1,052	16	7	2·69	2,091	1	11	2·07
Repayment of loan, principal and interest	1,231	6	2	3·14	1,415	2	5	1·42
	2,284	2	9	5 86	3,506	4	4	3 49

Official Announcements re Companies.

Notice is given in the *London Gazette* that the names of the undermentioned Companies have been struck off the Register, and are accordingly dissolved:—

Laing Electric Light and Power Company.
Lancashire and Yorkshire Electric Lighting Company.

The following will be struck off within three months, unless cause is shown to the contrary:—

Birmingham House-to-House Electricity Company.
British Electric Tramways and General Syndicate.
Brompton Electric Fittings Company.
California Gas, Water, and Electric Light Company, Syndicate.
Cheshire Electric and Steam Yacht Company.
"Energy" Gas, Electric Lighting and Power Company.
Lancashire and Cheshire House-to-House Electricity Company.
Lancashire Electric and Engineering Company.
Liverpool House-to-House Electricity Company.
Manchester House-to-House Electricity Company.
Midland House-to-House Electricity Company.
Northern House-to-House Electricity Company.
South of England House-to-House Electricity Company.
South Western District and Thames Valley Electricity Supply Company.
Western House-to-House Electricity Company.
Wyndham Electric Light Company.

The City of London Electric Lighting Company, Limited.—The warrants for interest due 31st ult. on the £300,000 5 per cent. debenture stock have been posted.

Hobart Electric Tramway Company, Limited.—The coupons of the first and second mortgage bonds due on January 1st, 1896, will be paid by the Commercial Bank of Scotland, Limited, 62, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 29th, 1895, were £890; week ending December 30th, 1894, £858; increase, £32; total receipts for half-year, 1895, £23,443; corresponding period, 1894, £23,305; increase, £138.

The Liverpool Overhead Railway Company. The receipts for the week ending December 22nd, 1895, amounted to £1,080; corresponding week last year, £938; increase, £142. The receipts for the week ending December 29th, 1895, amounted to £941; corresponding week last year, £837; increase, £104.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 27th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,329.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Dec. 23rd.	Closing Quotation Dec. 31st.	Business done during week ended Dec. 31st, 1895. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —105	101 —105	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	42 — 44	41 — 43	43¼	41
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	79 — 81	79 — 81	80⅝	80¼
2,993,560£	Do. do. Defd.	Stock	...	...	...	5⅝ — 6¼	6 — 6⅜	6⅜	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	12¼ — 13¼xd	13¼ — 13⅝	13 11/16	13¼
75,000£	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	5 %	...	111 —115	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1½%	1/16 — 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107 %	102 —105%xd	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅜% §	2 %	7⅞ — 8¼	8 — 8½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16 — 16½	16 — 16⅝	16½	16⅜
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17½ — 18	17½ — 18	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	125 —128	125 —128	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17 — 17½	17 — 17½	17⅛	...
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	127 —130	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	102 —106	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115 %	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	9½ — 10	9½ — 10	...	...
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16½ — 17	16½ — 17	16⅞	16½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝%	8⅝%	21¾ — 22¼	21¾ — 22¼	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 49	46 — 49	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	105	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅞ — 6⅛	5⅞ — 6⅛	6⅛	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	17⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15½ — 16½	15½ — 16½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼ — 6½	6¼ — 6⅜	6⅜	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	105 —107 xd	107½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	1/16 — 1/8	1/16 — 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	108 — 111xd	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	4 — 5	4 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½ — 3	2½ — 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	90 — 95 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½ — 6½	5½ — 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98—103	94 — 99 xd	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	9 — 9½	9 — 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 6⅝	6½ — 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	2⅜ — 3¼	2⅜ — 3¼	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	.⅞%	¼%	⅞ — 1⅛	⅞ — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10¼ — 10⅜	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	109 —112 xd	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½ — 5⅝	5½ — 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	2½%	5 %	5 %	6⅝ — 7¼	6⅝ — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 — 119	116—118 xd	116¾	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	12⅜ — 13¼	12⅜ — 13¼	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½ — 16	15½ — 16	...	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	131 —135 xd	135	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8½ — 9	8½ — 9	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10 — 11	10 — 11	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —120	115 —118 xd	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 9	8½ — 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼ — 8⅜	8¼ — 8⅜	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8¼ — 8⅜	8¼ — 8⅜	8 7/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Dec. 23rd.	Closing Quotation, Dec. 31st.	Business done during week ended Dec. 31st, 1895. Highest	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	1¼ — 1⅝	1⅛ — 1⅜	1 3/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	1⅝ — 2⅛	1½ — 2⅛	...	...
125,000/	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000/	City and South London Railway	Stock	6%	6%	1¼%	40 — 42	40 — 42	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1⅞ — 2¼	1½ — 2	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	...	...	.	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	...	4½%	104 —107	104 —107 xd	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	5/8 — 7/8	5/8 — 7/8	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2⅛xd	2 — 2⅛	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¼ — ½	¼ — ½	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	..	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	8 — 9	8 — 9	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	13½ — 14½	13½ — 14½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½ — 16½	15½ — 16½	16⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	108 —111	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	18 — 19	18 — 19	...	...
200,000/	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅜ — 11⅝	11½ — 11¾	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15½ — 15¾	15½ — 15¾		...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	39 — 41	41 — 43	41	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000/	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 5	4⅜ — 5	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 189
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%§ 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 95—100xd.
House-to-House Company (£5 paid), 3¾—4¼.
Do. do. 7 % Preference, of £5, 7⅞—8¼.
Do. do 4½% Debentures of £100, 110—112.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7⅓—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼

Bank rate of discount 2 per cent. (February 22nd, 1894).

ELEMENTARY CLASS TEACHING.

By W. PERREN MAYCOCK, M.I.E.E.

Now that the polytechnics and other institutions are entering on the second half of their session's work, it may not be out of place to record a few mild protests and pleas on behalf of the despised beginner, and the ill-educated student; these observations being mainly the result of some five years' constant teaching experience, and some eight years' close acquaintance with the electrical artisan and his needs.

In another nine months or so, the results of the City and Guilds of London Institute's examinations in the various branches of electrotechnics, and of the Science and Art Department's examinations will be made known; and while a good many of students will be able to congratulate themselves on their success, a far larger number will have nothing to show as the outcome of their attendance at the various classes.

The examinational results achieved by a class depend, of course, mainly on the method of teaching adopted, and according to these results, classes may be roughly divided as follows:—

(*a*) Those in which a comparatively small number of students pass in the higher grades.

(*b*) Those in which a comparatively large number of students pass in the lower grades.

Thus, in starting with a class, the teacher's policy will, generally speaking, be directed to one of two ends:—

(*a*) To get high, and therefore necessarily few examinational passes.

(*b*) To get many low class passes.

In most cases the teacher is influenced by the committee or principal under whom he works, and to show how the opinions of the latter officials differ, I may mention the following cases from personal knowledge.

(*a*) The Principal of a technical school in a very poor quarter of London, regarded as necessary qualifications for the head of the electro-technical department, that he should be able to prepare students for the Science and Art Honours examination!

On the other hand:—

(*b*) The Principal of a very similar institution, also in the midst of a working class population, expressed his opinion that he did not believe in examination results as a test of a teacher's ability, or words to that effect.

It is to be feared that the greater number of governing principals, teachers, and classes come under the first-mentioned heads, and that their duties to the class of students for which cheap technological (or technical) education is primarily intended, are gravely neglected; as proof of which take the well-known fact that very few real workmen or artisans are to be found among the students. They know too well that they will not comprehend the lecturer, and that he will not comprehend them.

If there were room and funds available for adequate treatment of the subjects in their various stages, well and good; but as a rule, funds are not plentiful, and the number of classes is restricted; so that we often find high prices being paid for instruments that only a handful of students will ever learn or need to use, while the practical wants of the less shining lights are overlooked. For instance, which is likely to be most useful to the average polytechnic student? To learn the use of a Kelvin balance, or the structure and repair of a few different types of ammeter; to make tests and calculations for B, H, and μ, or to see and handle various shapes of electro-magnet; to be dragged through a conglomeration of dynamo theory, illustrated with portions of ancient and modern machines, or to be familiar with the structure and management of a direct current dynamo or alternator; to know the manipulation of intricate instruments for tests that he is very unlikely to be afterwards required to carry out, or to fit up the various accessories

used in installation work, and be able to judge of their good and bad points; and so on, and so on.

Be it remembered that my remarks apply to the ordinary run of technical institutions whose fees do not exceed a very few shillings per session. They are the board schools of the profession, and their ostensible object is to educate the mass of electrical workers. Such shining lights as do crop up should be drafted to some higher college or institution, where better facilities for the treatment of intellectual activity are provided.

The policy of the teacher should be to constantly try back, and make continual fresh starts to pick up the laggards; not, as is so often the case, to single out the brightest specimens and lead them onward to the utter discomfiture of the majority of the class. In this latter case the teacher works for the benefit of the few, whereas his business is to work for the good of the majority.

Why will not the City and Guilds of London Institute grant certificates for the preliminary examination in electric lighting? The insignificantly extra expenditure involved would be far outweighed by the encouragement afforded to those who feel that their intellectual capacities are too poor to grapple with *the laws of Helmholtz and of Maxwell respecting sudden and periodic currents, hysteresis, work stored in a condenser*, and other matters mentioned in the ordinary grade syllabus. The fact that the examiners expect ordinary grade students to have a knowledge of quadratic equations, elementary trigonometry, logarithms, and the slide rule, practically shuts out hundreds—nay thousands—of real workers from this examination, and is an additional weighty reason for the granting of preliminary grade certificates.

I have heard it stated that students without such mathematical knowledge are no good for anything! Certainly no good for taking honours, certificates and medals, but surely some good for manual work, where a little knowledge, if perhaps sometimes a dangerous thing, is more often of the greatest use.

Teachers are frequently utterly regardless of the time necessary for the cultivation of the "electrical sense," otherwise "the capacity for thinking about that invisible and intangible something which we call electricity"; and are too prone to regard as hopeless certain students who, with patience, would bear good fruit: many of them are quite incapable of bringing themselves down to the beginner's level, or of expressing themselves in an intelligible manner. If they could only recollect their own early efforts it would be well; but few think of the years of patient and laborious work it has taken them to acquire their knowledge, and seek to impart it to perfectly fresh brains in the course of as many months.

These are strong sentiments, perhaps, but I think they are justified. The man who works in a factory, the dynamo attendant, the telephone linesman, the wireman, and various other classes of workers, have surely as much claim to consideration in this regard, as the youths fresh from school and college, who go to swell the ranks of "electricians" and "electrical engineers," but who, *as a body*, have little practical ability to show.

PRACTICAL EXPERIENCE WITH STORAGE BATTERIES IN CENTRAL STATIONS.*†

By C. L. EDGAR.

To those interested in selling electricity, it is a source of great satisfaction that the storage battery discussion has, within the past few months, especially in America, taken on an entirely new phase. It has become a question of use and not of manufacture.

For years we have all watched with great interest the various types of batteries put upon the market. We have discussed their value, at first confining ourselves as to whether they would work at all, and in later years broadening out the discussion as to how well they would work. We have watched the various companies interested in the manufacture of storage batteries fight one another in the courts, and we have wondered if it were ever to be possible to obtain a battery which did not infringe someone else's patent.

* A communication read before the American Institute of Electrical Engineers, November 20th, 1895.

† A brief abstract of this paper was published in last week's issue.

Until very recently it has not been possible to discuss from the standpoint of experience the economic merits of storage batteries, and it is particularly satisfactory to us to note that the discussion seems to have drifted away from the manufacturer to the user. To-night I am going to assume, at least for the purpose of this communication, that these perplexing questions have all been answered, and that we are finally on a par with our neighbours across the water, prepared to discuss the advantages of a commercial storage battery found ready to our hand.

Whatever may be the facts as to the existence of a commercial battery, some of us have purchased, and are operating, batteries which we consider satisfactory, and I will leave that part of the discussion to others, confining myself exclusively to their uses in an Edison system of circulation and distribution for lighting and power purposes in thickly settled communities. As it appears to me, their uses can be classed under four great heads, as follows:—

1. To carry the peak of the load at maximum hours.
2. To carry the entire load at minimum hours.
3. To act as an equaliser or reservoir.
4. For the equipment of annex stations.

There are many other special uses for batteries which can be naturally classed under one of these heads.

First, to carry the peak of the load.—In all systems of lighting, whether by gas or by electricity, there is a considerable portion of the connected load which is used only for two hours per day during the three or four months in winter. We have all of us, at various times, very earnestly discussed the probability of being able to widen out this peak, as it is commonly known, and numerous schemes have been devised by which it has been made more or less of a hardship for customers to use their light at this time, special concessions being made at all other hours of the day or night. It does not seem to me that any of these will avail. We cannot get around the fact that there are, in every large city, hundreds of stores which close up at six o'clock at night. The only need which they have for light is after it becomes dark. In this section of the country, darkness comes on about 4.30 in mid-winter, and these stores are bound to burn their light from 4.30 to 6 o'clock, and have no need of it at any other time. These are facts which are entirely outside of the question of electric lighting, and nothing which we can do will change them.

It matters not whether the company has a large motor load in the daytime or a large city contract at night. These are simply going to change the height of the curve at those hours. They are not going to alter the special shape of the curve due to the hour and a half of darkness during the business day.

This particular peak will be in some cases a much larger percentage of the total maximum output of the station than in others, but I think it is safe to assume that it is likely to vary only between one-third and one-half of the total. In the case of the company with which I am connected, we have found that if we divide our maximum load of the year into two parts, the upper half exists only for about two hours under ordinary circumstances, and four hours under exceptional circumstances for the five winter months.

Computing the kilowatts in these two halves, we find that the lower half contains 90 per cent. of the kw. hours manufactured, whereas the upper half contains only about 10 per cent. This would prove the position taken by some engineers, that if an extremely large station was to be constructed, it would probably pay to equip it with two types of apparatus—50 per cent. to be of the best economy and most expensive class known to the art. This to do 90 per cent. of the work. The other 50 per cent. to consist of crude, cheap, uneconomic, but reliable apparatus, to do the 10 per cent. of the work. The saving in interest on the lesser investment in the second class would be much greater than the extra cost of running this half, due to its poor economy.

In our particular case we find ourselves in precisely this position. Our company installed in years past about 4,000 H.P. of high speed, belted, bipolar apparatus, reliable but of poor economy. Some three years ago it changed to the other extreme, and commenced to equip with the highest priced and most economical apparatus to be found in the market, and to-day there is about 4,000 H.P. of this apparatus in use.

The data which we have for 1894 and 1895 proves the statement which I have just made. Ninety per cent. of our kilowatts have been manufactured by the vertical, triple-expansion, multipolar units, and yet the total capacity of this apparatus is not over 50 per cent. of our maximum output for the winter.

The application of the storage battery to these conditions is obvious. What we need and what all companies under generally like circumstances need, is a piece of apparatus capable of doing two hours' work per day which is cheap, and which has fair economy. If storage batteries could be used under no other circumstances than these, it is, perhaps, somewhat doubtful whether it would pay to instal them, but yet I am inclined to think that considering their first cost and the efficiency which we can obtain from them, it could be fairly proved that it would pay to use them rather than what I have designated as the cheap type of apparatus.

At the time our first battery was purchased, our standard unit was 650 H.P. We therefore called for a battery of 650 H.P. capacity for two hours. We eventually, under stress of circumstances, reduced this to one and a half hours, and found that it cost considerably less than a first class steam plant.

As all apparatus has to be installed for the express purpose of taking care of the maximum load, it seemed to us very clear that if we could save in our first investment by installing storage batteries which cost less than a steam plant, we were going to be able to do a given amount of work with a less amount of capital by this means than by any other. We thus decided to instal a battery to take care of the peak, even if we obtained no other advantage from it.

Second, to carry the entire load at minimum hours.—I think that the nature of the load curve in America is against the use of batteries

for this purpose to anything like the same extent as abroad. With us there is only about six hours of minimum load, whereas, owing to the lack of motor business in Europe, the minimum there extends some days from midnight until three o'clock in the afternoon. Our minimum is so short that we are not able to save one shift of men, nor are we able to save much in the fixed boiler room expenses from drawing the fires, banking the boilers, or any of the various other expedients used when the plant is not in operation.

Our generating department has gone through some exhaustive experiments, running first the engines for 24 hours a day, charging the battery at minimum load, and then turning around the next week and shutting down the steam plant for the six hours from midnight until six o'clock in the morning, and depending entirely upon the battery. The general conclusion seems to have been arrived at that the former is the cheaper method. Admitting this, the indirect advantages of the former, by which the battery is charged during the night, and can be used during the following day, are very much greater than if the battery were discharged during the night, as it could not be completely charged again until the middle of the afternoon of the following day.

I do not consider our conclusions final, as the local conditions might materially change the result. In our case it happens that the output at night plus the charging current of the battery, is just equivalent to one of our standard units. If it were necessary to run two units to do this work, our conclusions might have been different, so that I think this is a case which has to be decided in each place on its own merits.

Third, to act as an equaliser or a reservoir.—It is this use of the battery with which we have been particularly pleased, and in order to understand, it is perhaps desirable to explain the needs which a modern station has for apparatus of this kind. Years ago a distribution company was equipped with one station, furnishing electricity through a system of feeders, supplied from one bus bar. All this is changed. To-day the modern station manufactures electricity in various places, transfers it from one station to the other at will, sends it out through a system of distribution at three or four pressures supplied from bus bars of varying potential. At the minimum hours of the day the electricity is manufactured by one set of dynamos, part of it being delivered to the 'bus bar in the station in which the dynamos are located, the remainder being sent out over tie lines to various annex stations and delivered there to the local bus bar. The amount of current is so small compared with the capacity of the various circuits that, practically, the pressure delivered at the lamps is constant, notwithstanding the various roundabout ways in which it reaches them.

As the load begins to increase, the drop over the tie lines becomes noticeable, and it is necessary, by means of auxiliary dynamos known as boosters, to raise the potential of that part of the output which is delivered to the tie lines.

The load still increasing, it is necessary to start additional dynamos. These may be thrown in multiple directly with the original pair, and deliver the same potential as the others, or, if the condition of the load warrants it, they may be thrown in multiple with the original dynamos and the booster in series, and deliver the potential needed by the tie line. In this case the booster might be taken out of circuit.

The load on the tie line again increasing, the booster would be again put in use, and we would thus have the condition of a tie line supplied partly by a dynamo of the proper potential, and partly by additional current furnished by a booster, raising the potential from another bus bar supplying current locally.

This goes on until nearly the maximum load is reached. It then may be found, as it is sometimes in our case, that the original or main station is not equipped with sufficient dynamos to supply the local distribution. In this case the current over the tie line is reversed, and the annex station sends current to the original station, which arrives there at somewhat lower potential than is needed, and is there raised by means of a booster to the bus bar of that station. It is necessary to understand that these are everyday occurrences, and if we were not equipped with a battery, it would be almost an hourly question as to what it was necessary to do next, whether to start dynamos, stop them, change boosters, or any other of the innumerable combinations which might be made. This trouble is intensified by the uncertainty as to what changes are going to take place in the output, and what the load is going to be at any given time. In a very large degree the battery answers all these questions, or, at least, makes them unimportant. It makes it possible to determine beforehand what the regular day's work of the steam plant is to be, to decide how many, and at what time, boilers are to be put in service, when engines are to be started or stopped, and, in general, to operate the plant to its best economy, knowing that daily or hourly inequalities in the load, or uncertainties caused by the weather will be taken care of by the battery.

It is kept in multiple with one or the other or all buses at all times. It is supposed, for many hours of the day, to be standing idle with the ampèremeter at zero, but it may, without a moment's warning, be called upon to either give or take anywhere from one to 3,000 ampères on a side. It is possible in this way, theoretically, to keep every engine which is running loaded up to its maximum economy at all times. Practically, we have found it possible to never operate an engine with less than three-quarters load. The economy of the steam plant then more nearly approximates what is known as mill practice, which is the goal toward which we are all striving.

Having satisfied ourselves in the beginning that, with a given amount of capital, we could do more work with the battery than without it, we, by actual practice, came to the conclusion that we could, by the same means, do this same amount of work more cheaply. When we remember that we installed the battery for the express purpose of taking care of the maximum load, we are, of course, particularly pleased at the very great use we can make of it for this purpose of equalisation, and yet, in addition to this, we have made enough tests to prove to our own satisfaction that we do not lose anything in fuel economy by this particular use of the battery. The watts lost by the inefficiency of the battery are made up more than fourfold by the better economy of the steam plant. We have taken typical winter days, and figured out exactly the cost of running our system with the battery and without, and have proved that the actual coal consumed with the battery is a material amount less than without it. If, in addition to the fuel, we take into account the very great saving in the labour, the added reliability, and the better service given, we will see that these uses of the battery are even greater than those for which it was originally installed.

I do not think it is possible to overestimate the advantages of storage batteries for the purpose of giving regularity and reliability to a system of distribution. With very sudden fluctuations in the load, which are continually taking place, it is almost impossible, with dynamos alone, to regulate the bus pressure so quickly that the pressure throughout the system remains constant. Of course, we have done this for years to the best of our ability, but it has necessitated keeping everything in first-class shape, and having the employés of the company on the alert at all times to take care of this question. The uses of the battery very much simplify this problem. Very many times, where in the past it was necessary to change the magnetism of the fields of dynamos, it is now necessary to do absolutely nothing, the battery acting as a reservoir, giving out quantities of current without any apparent change in pressure for the time being.

This question of regularity is very closely connected with the one of reliability. To those of us who are identified with central station work, there is a great sense of security when we realise that whatever may happen to the steam plant, we have sufficient battery to carry us over a few minutes of disorder. In our particular case, we have at the present time sufficient battery to run 60,000 lamps for five, 10, or 15 minutes, depending upon how great is the emergency. This advantage of the battery may not appeal to an outsider. I do not think they can realise the intense nervous strain to which all connected with the successful detailed operation of the station are subjected. If a battery and a steam plant were on a par in all other respects than this, I should personally feel very much inclined to instal it for this reason alone.

4. *For the Equipment of Annex Stations.*—This is a use to which we have looked forward with great interest, but up to the present time have had no occasion to make the use. There are in every city certain sections, located so far from the centres of distribution, that it becomes a very serious and expensive matter to reach them with the regular three-wire system.

When we realise that it makes very little difference to which end of a tie line a storage battery is connected, we can see at once the special advantage which this type of apparatus gives us. If of such value that it will pay to instal them, it is a matter more or less immaterial whether they are installed at the main station, or at an annex station connected to the main station by tie lines.

The fixed charges of running a battery room are very small as compared with those of a steam station, and there would not be any very material increase of fixed expense between one large battery located in a central point and half-a-dozen small ones distributed throughout the city.

Storage batteries, therefore, lend themselves particularly to the location of a "central" station at some convenient point upon the water front, and the building up of small centres of distribution scattered throughout the city, consisting of storage batteries with or without a steam adjunct, and connected together possibly, but certainly each one connected to the central station.

This communication may be considered to have been written upon very narrow lines, and I may say that this was intentional. So much has been written during the past few months upon generalities and upon possible cases which may or may not exist, that it is sometimes valuable to brush these all on one side, and to confine oneself to some specific cases. This I have tried to do.

Our company has used the first battery 20 months, and one of double its capacity for six months, entirely too short a time to come to any conclusions about the depreciation, but it has given us ample time to satisfy ourselves as to the economic value. It is sufficient for me to say that if a need should arise to-morrow for additional capacity, either at our main station, at either of the annexes or in any new part of the city, within reasonable distance of our centre of distribution, we should consider the question along the lines which I have just indicated. We should eliminate entirely from the discussion the question which has distracted the public mind for so many years, and decide it entirely upon its merits, placing the battery side by side, and on an equality, with other modern and improved apparatus.

AMERICAN ELECTRO-THERAPEUTICS.

The third annual meeting of the National Society of Electro-Therapeutists was held at Hotel Vendome, September 18th and 19th, 1895.

Secretary Clara E. Gary, M.D., reported an increase of 25 members during the past year.

Treasurer J. B. Garrison, M.D., reported the finances of the Society to be in a good condition.

The President (W. H. Joeleson, M.D.), then gave the annual address upon "The Development of Electro-Therapeutics, and its Relation to the Practice of Medicine." He advised all physicians to investigate the subject, and satisfy themselves of the value of electricity as a therapeutic agent. There are clearly defined indications

for its use, he said, and it has a sphere of usefulness all its own which must be recognised. Then followed many interesting papers. Among them, a number showed original investigation in new fields.

The first paper read was that on "Some Experiments on Cataphoresis and Anaphoresis," by Prof. W. H. King, M.D., and Dr. F. M. Frazer. The authors divided electrical osmosis into cataphoresis and anaphoresis, and stated that their experiments proved conclusively that the positive, and not the negative, pole attracts iodine—a result in direct opposition to the previous belief.

"Catalytic Effects of the Galvanic Current" was a paper by Chas. Porter Hart, M.D., Wyoming, Ohio, in which he stated that his practice was to place the cathode upon the seat of the trouble in acute and sub-acute cases, while in chronic cases, especially if complicated with paralysis, he uses the anode at the seat of the disease.

In a paper entitled, "Is the Practice of Electro-Therapeutics a Fad Practice?" Dr. E. S. Bailey, of Chicago, Ill., says that the results attained in private practice had convinced him of the efficacy of electricity, and said it is those who do not understand it who call it a fad.

"Electricity in Dyspepsia," by Dr. M. T. G. Lajoie, New York, was the next paper. The doctor found great benefit from the use of static electricity in dyspepsia, especially those cases complicated with neurasthenia.

Mr. J. Emory Clapp, of Boston, gave a review of the first principles of electricity.

Mr. T. F. Livingston, of New York, discussed "The Difficulties of Utilising Commercial Currents for Therapeutic Purposes from an Electrician's Standpoint," and he showed the undesirability of the use of the street current in ordinary electro-therapeutical work.

In "Treatment of Rheumatism by Electricity," Chester G. Higbee, M.D., St. Paul, Minn., gave as his experience that he had found benefit from the use of electricity in rheumatism, using the indicated remedy under the positive electrode applied to the diseased parts.

The next paper was entitled "The General Therapeutic Effect of the Alternating Electric Current of High Frequency and of High Tension," by Dr. G. Apostoli, Paris, France. The doctor has found it beneficial in those cases where there is defective nutrition, particularly in rheumatism and gout.

The paper written by William Harvey King, M.D., of New York, on "Locomotor Ataxia" was very interesting. He made the point, that failure in the treatment of locomotor ataxia is largely due to an improper selection of the kind of current in different stages of the disease. He finds in the first stage more benefit from the galvanic current. Static electricity holds a prominent place in the treatment in the later stages. The case in which electricity is indicated should be carefully chosen, and promises should not be given regarding its permanent effect.

Following this paper came "A Review of a Case of Bell's Paralysis," by Julia Gould Waylan, M.D., Phil., Pa. Then came a paper by N. B. Delamater, M.D., Chicago, Ill., on "The Selection of the Current in the Treatment of Neuritis." In cases of chronic neuritis, the inflammation having subsided, but malnutrition and partially paralysed muscles still existing as the result of the neuritis, the faradic current should be used, as it stimulates nutrition, restores natural contractility, and overcomes abnormal contractions.

"The Mitigating Effect of Spinal Galvanisation upon the Subjective Symptoms of Tabes." Frank C. Richardson, M.D., of Boston, reported very good results from the use of the ascending current from 15 to 25 m.a., making the anode active over every part of the spine moving up.

"Do Electrical Currents affect the Spinal Ganglia?" by E. P. Colby, M.D., Boston, brought out considerable discussion, showing a diversity of opinion, and yet it was generally believed that a certain portion of the current would find its way to the spinal cord itself.

F. M. Frazer, M.D., of New York, in his paper entitled "Faradic Polarity" showed that the recent belief that there was no difference in the poles has been entirely disproved, and that the break-current predominates. It does have a slight polar effect, as was shown by its action on iodide of potassium and starch.

The evening session opened with a paper by J. Inglis Parsons, M.D., M.R.C.P., London, England, on "The Disintegration of Organic Tissue by High Tension Currents." Dr. Parsons showed that it is possible to cause distruction of tissue by means of rapid alternation of high voltage current, but of small ampèrage. This does not cause sloughing, but is followed by atrophy of the tissue treated.

Prof. William L. Puffer, of Boston, in his paper on "Polyphased Currents and their Effects," said that polyphased currents are only alternating currents produced by a dynamo at the same time, only out of step, as it is called, or at different periods from each other.

"Polyphased Currents," by Profs. Edwin J. Houston and A. E. Kennelly, Phil., Pa. (which we print in another column), maintained that, from a physical point of view, it is not probable that any peculiar physiological effect can be expected by the use of multiphase currents in contradistinction to ordinary uniphase currents. If the existence of such effect can be demonstrated, it will be dependent upon the existence of some time relationship between the development of the current waves in regions where they cross each other's paths at nearly right angles.

"Electro-Magnetic Basis Physiology," by Prof. A. E. Dolbear, Tuft's College, Mass., gave activity of every kind as the basis of all physiology. The body is an electro-magnetic machine, and electro-magnetic conditions regulate all its functions. These considerations give validity to a rational basis for electro-therapeutic study, and we may look forward with confidence to the time when all kinds of ailments will be intelligently met by electro-therapeutic practice.

"The Fundamental Relations of the Sinusoidal or Undulating or Other Forms of Current in their Action on Nervous Tissue," by Walter Y. Cowl, M.D., Berlin, Germany, was heard with interest.

"L. Willard Reading, M.D., of Phil., Pa., gave a paper on "Cases of Malignant Growth treated by Electro-Puncture." He said he had had great benefit result from electro-galvanic puncture in cases of malignant disease. "Some Points in the Treatment of Stricture of the Urethra by Electrolysis," by Prof. William Harvey King, M.D., of New York, attributed the failure in the treatment of stricture of the urethra to an improper knowledge of the anatomy and physiology of the structure. Also, to improperly constructed instruments. Strictures are most common in the membranous portion of the urethra, just in front of which is a pouch where most of the instruments lodge, and cannot be made to enter the stricture. This he proposes to remedy by making the staff of the sound larger to uniformly distend the canal, and to have the curve of the instrument correspond to the normal curve of urethra.

"Electricity in Orificial Treatment," by C. A. Weirick, M.D., Chicago, Ill., showed the benefit derived in diseases of the orifices by the use of electricity.

"Hypertrichosis and its Treatment by Electrolysis," by John L. Coffin, Boston, described the process of removing hairs. Dr. Coffin does not believe that their removal necessarily increases the growth of those remaining.

Drs. G. Gautier and T. Larat, Paris, France, gave some interesting notes on "Electro-Therapeutics," showing the local action dependent upon nascent products are superior in their effects to those of any other application.

Geo. E. Percy, M.D., of Salem, Mass., gave a paper on "Treatment of Procidentia Uteri by Faradic Current."

Emily A. Bruce, M.D., of Boston, in the "Electrical Treatment of Dysmenorrhea," said that she found both the faradic and galvanic current helpful in these cases in conjunction with hygienic measures.

Jeannie W. Martine, M.D., of New York, gave "A New Method of Dilating with Faradaism."

"Electricity as a Means of Diagnosis in Gynecology," by Dr. G. Apostoli, Paris, France, explained the usefulness of electricity in these cases. The faradic current will relieve nervous and hysterical pain, but is powerless where there is inflammation, which is indicated by febrile reaction. The same study of the so-called galvanic reactions inform us rapidly of the curability of these inflammatory lesions, which the electric current has demonstrated, and in consequence of this, tells us in one case to abstain from an operation, while in another it shows operation to be urgent. Gynecological electro-therapeutics, carefully and methodically applied, aid surgery instead of opposing it.

"Reports of Gynecological Cases," by Minnie C. T. Love, M.D., Denver, Col., was the next paper.

"Ovarian Cyst with Laparotomy," was the subject of a paper by M. Bonner Flinn, M.D., Worcester, Mass.

"The Proper Application of the Electric Cautery for Nasal Diseases," by Wesley A. Dunn, M.D., Chicago, Ill., gave the preference to the electric cautery over other escharotics, as more under control of the operator, and is followed by less reaction.

"Electricity in Diseases of the Pharynx," by Thos. L. Shearer, M.D., Baltimore, Md., stated that in electricity the doctor finds a valuable adjuvant in his practice, relieving cases that are intractable to other measures.

"The Use of Galvanism in Diseases of the Larynx," by J. B. Garrison, M.D., of New York, said that in cases where there is lack of nutrition of the laryngeal apparatus, much benefit is received by using the interrupted galvanic current applied over the inferior or recurrent laryngeal nerve, stimulation of which increases the nutrition of the vocal apparatus.

Honorary membership was conferred by the Society upon Prof. A. E. Dolbear, Tuft's College, Mass., Prof. William L. Puffer, of Boston, and Drs. G. Gautier and T. Larat, Paris, France, and Dr. J. Grand, Paris, France. Also Profs. E. J. Houston and A. E. Kennelly, Phil., Pa.

The following officers were elected for the ensuing year:—President, A. B. Norton, M.D., of New York; Vice-Presidents, F. A. Gardner, M.D., of Washington, D.C, and Clara E. Gary, M.D., of Boston; Secretary, F. M. Frazer, M.D., New York; Treasurer, J. B. Garrison, M.D., of New York; Executive Committee, W. H. King, M.D., of New York, and W. L. Jackson, M.D., of Boston.

It was unanimously voted that the meeting was the most interesting of any that has been held.

POLYPHASE CURRENTS.*

BY EDWIN J. HOUSTON, PH.D., AND A. E. KENNELLY, SC.D.

POLYPHASE currents are alternating currents of the same frequency, differing mutually in phase by a definite amount.

Polyphase currents consist of at least two separate and distinct alternating currents, and although the number of such separate alternating currents is unlimited, yet, in practice, rarely more than three are employed. When two such separate alternating currents are provided, they form that system of polyphase currents usually called diphase currents; and, when three such separate currents are provided, they are usually called triphase currents.

Since polyphased currents consist, as has been stated, of separate and independent alternating currents, it is necessary, at the outset, that the peculiarities of alternating currents be thoroughly discussed before proceeding to the effects of their combination.

An alternating electric current is a current that periodically varies its direction, and in this respect is in marked contrast with the con-

* Read at the National Society of Electro-Therapeutists, America.

tinuous current which constantly maintains the same direction. Alternating currents differ in three ways:—

1. In their frequency, or the number of times per second in which the direction of flow is changed.
2. In their amplitude or strength, as measured in ampères.
3. In their wave form.

The frequency of vibration of a tuning fork is the number of to and fro movements, or double vibrations per second, of the fork. For example, a tuning-fork sounding middle C makes 512 single beats, or 256 complete to and fro motions in a second, so that its frequency is 256. In the same way, the frequency of an alternating electric current is the number of to and fro movements or double vibrations per second of the current. For example, the alternating current which produces in a telephone the tone of middle C, has a frequency of 256 complete double vibrations; that is, it causes the diaphragm to move in and out 256 times in a second, 256 times inwards and 256 times outwards.

In the alternating currents employed in the commercial application of electricity the frequency is lower, being from 140 to 25 periods, or double vibrations, per second. A period is the time required to complete one to and fro motion or double vibration.

In what is sometimes called the static induced current, but which, from a physical standpoint, is better described as an oscillatory or rapidly alternating discharge, the frequency of the oscillations may be several hundreds of thousands, the discharge, however, being so brief, that the actual number of oscillations in one discharge is comparatively small. In the experiments with high frequency currents, generally called Tesla currents, the frequency has been carried to some millions per second, and in the electric oscillations constituting light, the frequency is hundreds of trillions per second.

The strength of an alternating current, like that of a continuous current, is measured in ampères. Alternating currents employed for operating powerful electric motors may have a strength of hundreds of ampères. The effective strength of an alternating current supplied to operate an ordinary incandescent lamp at 100 volts pressure, is about half an ampère. The strength of alternating current employed to operate a telephone is about $\frac{1}{10000}$th of an ampère. The strength of current employed in electro-therapeutics is generally from a small fraction of $\frac{1}{1000}$th of an ampère, or of one milliampère, to about 10 milliampères, although greater strengths are occasionally used.

The apparatus employed for producing alternating currents may be of three kinds.

1. Commutators employed in connection with continuous sources of electromotive force, such as a voltaic battery.
2. Alternating electro-dynamic machinery, such as alternating current dynamos, and induction coils, sometimes called faradic coils.
3. Condensers charged by static or influence machines, and discharged into circuits of suitable proportions.

An alternating current may be regarded in its to-and-fro motions as producing electric waves, the graphic form of representation of which varies according to the character of the apparatus producing it. Thus, with a commutator, the current rises almost immediately to its full strength at each reversal, thus tending to produce a wave of the rectangular type. The typical form of alternating current wave is, however, a form known as a sinusoidal or sine wave, which is the form of least average variation in current strength, or the smoothest type of alternating current that can be produced.

It should be remembered that multiphase currents differ in no respects from simple alternating currents, save in the fact that at least two separate and independent simple alternating currents are employed, of the same frequency, and in certain definite phase relationship with each other.

When two separate alternating currents in separate circuits begin and complete their to and fro motions at the same times, they are said to be in step, or in phase. If, however, the time of beginning or completing the waves is not the same, they are said to be out of step, or out of phase, with each other. Regarding an entire period as a cycle or step, then if one of the alternating currents differs from the other by a quarter of a step, the currents will be diphase or quarterphase currents, and the one wave is at its maximum when the other wave is at zero.

Similarly, if three currents of the same strength and frequency, in three separate circuits are out of step by one-third of a period or cycle, the three currents are said to be triphase currents.

A system of multiphase electric currents necessarily requires more conductors for its installation than a system of a single ordinary alternating current, *i.e.*, uniphase current. Moreover, more complex generating apparatus is required to produce a multiphase system of currents than a uniphase system. Thus, in the diphase system, four separate conductors, two for each separate alternating current (one going and the other returning) are usually employed, although it is possible to employ only three wires, one being the common return for the two currents. In the triphase system, only three conductors are employed, one for each current, each wire acting as a return for the other two circuits.

The complexity thus introduced into alternating currents by the use of multiphase systems would, therefore, never be adopted in practice, were it not for the advantages that such currents possess for the starting of alternating current motors, *i.e.*, electric motors operating on alternating current circuits. No alternating current motor has yet been devised which is capable of being started from rest on an ordinary uniphase circuit, although when once started and brought to speed, they will run on such circuits; and the multiphase system was invented for the purpose of enabling such motors to be started at full load from a state of rest. In ordinary commercial practice, multiphase alternating currents are only employed for this purpose, although a multiphase system once installed, enables lamps or any other device which is operated upon the ordinary uniphase system, to be employed on any separate branch of the multiphase system.

Multiphase motors are capable of starting from rest at full load, and behave in this respect like continuous current motors.

Multiphase motors themselves may be divided into synchronous or asynchronous, namely, those which run in synchronism with an alternating current, and, therefore, have only one working speed, and those which will run at any speed less than the synchronous speed, and which are called induction motors or asynchronous motors.

So far as is known, no physical effects are attributable to alternating currents over and above those produced by ordinary uniphase currents. Suppose, for example, that a triphaser, *i.e.*, an alternating current dynamo designed to produce three triphase currents, be connected so that it can send these three currents through three separate circuits. In each of these three separate circuits, the currents, and all the effects which those currents produce, are simply the effects of an ordinary uniphase current. Even in a triphase motor, where the circuits are so related as to utilise the effect of combination, and produce what is called a rotary magnetic field capable of starting the armature, the current in each circuit, and the effect at each point, is simply that of a uniphase alternating current.

If four wires be led from a diphaser, or a source of two diphase currents, to four electrodes placed at any points upon the body of a patient, there would be produced two simple alternating or uniphase currents, one in each circuit between its pair of electrodes. Before it can reasonably be expected that such diphase currents should possess some peculiar physiological action, it must happen that a peculiar time relation exists whereby the effect of one current having its maximum strength while the other current is passing through zero, produces a special physiological influence; otherwise the effect must be the same as a double application of an ordinary uniphase current. Morever, if such time relationship did exist, it could only be utilised where the currents in the two circuits crossed each other at right angles, for if the electrodes were placed so that the two currents passed parallel to each other through the same path, the two currents would be precisely equivalent physically to a stronger current of the uniphase or single alternating current type, midway in phase between the two separate currents, for it can be shown that if two diphase currents are discharged into a common conductor, they cease to have individuality, and there is produced a single uniphase current of the same frequency, increased strength, and of a phase intermediate between the two. Moreover, if the wave form of these individual currents be assumed to be sinusoidal, the resultant current formed by their union will be also sinusoidal. In other cases the resultant current will differ in wave form from that of the components.

From a physical point of view, therefore, it would not seem probable that any peculiar physiological effect can be expected to be produced by the use of multiphase currents in contradistinction to ordinary uniphase currents. If the existence of such an effect can be demonstrated, it will be dependent upon the existence of some time relationship between the development of the current waves in regions where they cross each other's paths nearly at right angles.

ELECTRIC TRACTION IN AUSTRALIA.

[FROM OUR SPECIAL CORRESPONDENT.]

THE latest proposal with regard to the electric traction question is to construct a short section from the foot of Erskine Street, Sydney, up to and entering George Street, at the post office corner, with a further possible connection with the present tram service in Elizabeth Street. The gradient up Erskine Street is pretty severe, about 1 in 11, and the traffic would probably be heavy, as it would connect with a number of ferry services from Balmain, Lane Cove River, &c. The Minister for Works, Mr. Young, points out that the Public Works Committee will not be able to report on the proposed electric tramway along George Street until Parliament meets again, probably about March next. Another loan bill would also have to be passed before the George Street line could be constructed. The actual work of constructing the line will also necessarily take considerable time, and it is probable that it will be two years at the earliest before the George Street tram will be running. The short line from Erskine Street to George Street will not cost so much as to require to go to the Works Committee, and it can consequently be put in hand at an early date. Mr. Young says that owing to the heavy traffic up Erskine Street he believes the proposed tram would pay well, and it would also be an object lesson upon the capabilities of the electric system. Mr. Young has had several interviews with reference to this question with Mr. Eddy, Chief Commissioner for Railways, and Mr. Deane, Engineer-in-Chief for Railway Construction; and it is reported that several interviews have been held between Mr. Eddy and Mr. A. R. Jones, the representative of the General Electric Company of New York, who is now in Sydney.

Apropos of this question, in your "Electric, Traction and Motive Power Notes" of September 27th, you quote a Sydney paper as stating that the Waverley-Randwick electric tramway has been working at a loss, and is not paying half working expenses. This is somewhat misleading, as the Waverley-Randwick line has not been worked by electricity for some two years, and moreover, on account of the small traffic has never paid expenses from its inception. The electric plant was removed about two years ago, and re-erected at North Sydney on what is known as the Military Road Line. The working of this line was the subject of a paper read before the last meeting of the Electric Club of N. S. Wales by Mr. G. F. Clements, A.I.E.E., a summary of which paper I attach.

The road is single track, 2 miles 12 chains long, with a loop at either end, and a passing loop, or side track, 60 chains from the power house. The cars run on a portion of the new cable road, a distance of about 20 chains of double track. The track is laid with 90 lbs. vignole steel rails with 35 lbs. guard rails, the rails being in 24 feet lengths, and the joints of the rails and the guard broken. Ironbark

sleepers, 8 feet × 9 inches × 4½ inches, are used, laid on good ballast, and spaced 2 feet 8 inches centre to centre. The road is not paved or pitched, but since the line has come into operation, a great portion between the rails has been laid with small metal treated with boiling tar. The gauge is standard 4 feet 8½ inches. The gradients are fairly severe and very numerous. From the power house to the terminus 52·6 per cent., and on the return journey 46·3 per cent. of the distance consists of rising gradients, though the difference of level between the two ends is only 13 feet. The level track throughout amounts to 2 per cent. The steepest gradient is 1 in 16·59, or 6·03 per cent for a length of 198 feet, and this on a curve of 1,327 feet radius. The longest gradient is 1 in 28, or 3·57 per cent. for a length of 1,056 feet. There are 19 curves in the road, the sharpest having a radius of 103½ feet, and an arc of 132 feet. The flattest curve has a radius of 2,649 feet, and the longest curve has an arc of 264 feet. At one portion of the road a reverse curve occurs of 132 feet radius, 165 feet arc, with 68 feet of straight.

The overhead track on the cable road and loops is of span wire supension, and on single line it is single bracket suspension. In the former the overhead wire is supported by means of a No. 6 B and S galvanised steel wire, strained between a pair of brackets on opposite sides of the street, the brackets being of wrought iron lattice work, and mounted on ironbark poles. The curvature of the bracket is approximately the fourth part of an ellipse. The overhead wire is of hard drawn copper, ⅜-inch diameter, soldered to rods supported by old type compressed fibre Thomson-Houston insulators with clip; a No. 6 span wire being used. On the single track the method of suspension is as follows: An oregon timber is housed into the end of the bracket, and bolted with wrought-iron straps on either side. This timber carries two Johnson & Phillips oil insulators, the iron pin of the insulator passing through the oregon, with washer and nut on the underside. A wrought-iron hanger is lashed with No. 16 galvanised iron wire across the tops of these insulators, the end of the hanger being screwed or flattened to take the bolt. A small brass casting screws on to the hanger, and the jaw of the casting takes the lug on the ear, the two being held together with a bolt. On the curves a heavier class of hanger is employed, stamped from a piece of ¾-inch rod. The frogs or turn-outs are gun-metal castings, of the usual T.H. pattern. The trolley wire is anchored at several points along the road. Owing to the construction of the trolley and fork, very few pull-overs are used. The insulation of the line when completed measured half a megohm. The return is composed of a ⅜-inch soft copper wire, bonded to both rails at every 120 feet with channel pins; this wire is laid immediately on top of the sleepers.

The conductivity resistance of line and return was 1·6 ohms by bridge measurement on completion of work. By measuring on August 13th, 1895, with ammeter and voltmeter, the resistance, including line and return, switchboard connections, brushes, contacts and armature = 1·7 ohms. Some 12 months ago it was deemed advisable to connect the rails and return to the water pipes and main in the vicinity and along the route, and with the concurrence of the Water and Sewerage Department, this was carried out. After determining the points to be connected, the ground was opened up and the main or branch exposed. The portion making contact was thoroughly cleaned and brightened, and a wrought-iron collar 2½ inches × ½ inch used to clamp the copper binding wire to the pipes. After being screwed up as tight as possible, the whole connection was coated with boiling tar.

THOMAS ALVA EDISON'S APOTHEOSIS OF THOMAS ALVA EDISON.

(*With profound apologies to* ELECTRICITY, *of New York.*)

I'm the "Wizard of Menlo Park,"
Robert Houdin, Anderson and Dr. Lynn
Were but fools beside *me*.
Ex nihilo nihil fit,
Chestnuts!
I rose from *nothing*,
Thomas Alva E.
I was a newspaper boy,
and so know how
to fool the Press;
yes! I guess.
The Press is easily fooled,
especially the *D. T.*,
by *me*.
Before I was ten
I had the "History of the World"
in my almighty brain.
Since then History has been made
by *me*.
I am the greatest electrician
the world has ever seen.
This is proof that there
is no abnormal or one-sided
development of
genius
about *me*.
Genius is but an exhaustless
capacity for work
in detail.
The all but perfected work
of others
just lacked the detail which was
invented
by *me*.
The telephone, the phonograph,
both belong to me
The graphophone! well
'taint a phonograph, and Tainter
Aint *me*.
The microphone's Hughes's!
British bluster,
for by side of me
Hughes he!
The electric incandescent light
The heated bamboo filament
Was brought about by *me*.
Swan! you say, not he!
You can't bamboozle *me*.
Not even the simple vacuum
which is abhorred by Nature.
What rot!
Nature's controlled by *me*.
I invented a dynamo
(Not "Jumbo")
A tuning fork machine
A diapason normal.
From the lowest depth of the
deep deep C
To the highest pitch
of Hertzian waves
Whatever that may be,
That darned machine would hum,
for *me*.
Forbes, George Forbes,
London, England, reckoned
he'd harnessed Niagara
But he reckoned
without *me*.
Forbes may blow his bazoo
But I'm blowed
if he can beat
me.
I never brag about what I know,
And what I don't know aint worth knowing,
but when I open my mouth
and begin to spout language
about what I'm going to do,
Niagara isn't in it
with *me*.
I swore by the hand of Vanderbilt,
By his clean hand I swore,
that the noble house of Crespo
Should suffer wrong no more.
I am on the war path,
and my energy I devote
to the service of my country.
By the all-powerful nature
of my electricity
I will amaze
the English nation.
Hail Columbia!
The American eagle is soaring
higher than a kite,
The star spangled banner is unfurled
to the sweet breezes in New York harbour,
the awe inspiring strains of "Yankee doodle,"
America's national anthem,
are borne on the wings of music,
and I scent the battle from afar.
I
whose inventive genius
has hitherto been devoted to appliances
of Peace,
Challenge the played out British Empire
to mortal combat
To fight *me*.
Out Dunraven, England's yachtsman,
He the proud and haughty sportsman,
He who sought to cast discredit
On our brave *Defender's* fame,
On the straight and handsome manner
beaten at his own game,
My inductive ballast shifter
sent him beaten whence he came.
At the meeting of the Waters
of the Horse-shoe and our own fall,
Ni-a-gara will be charged,
charged with full 5,000 volts
Continuous, not alternating,
volts of high potential
volts devoid of covering
big as lumps of chalk,
volts produced by *me*.
My multi-triphased motor
My vertical spindle motor
My mushroom armature motor
(The so-called Forbes idee)
will hurl these dreadful engines
these dire destructive weapons

more terrible they than dynamite
Cordite or special Dewar
through the snorting nozzle,
The nozzle of a 3-inch hose
supplied at mighty pressure
a simple modification
of the artifice I used
to cool the red-hot bearings
of "Jumbo's" mighty frame
whose elephantine grace
aroused the angry passions
of a coon, an F.R.S.
who once tried to "possum" *me.*
He who tried the 3-wire dodge
To get a rise on *me.*
The tarnation Britisher will be swept
from the face of the earth
like chaff.
My chaff.
Distance is no object.
My volts gain strength
not lose potential,
in hurtling through the air.
and charged with the same
determination to overcome resistance
which dominates me,
Niagara's mighty power
will be carried
to Infinity
by *me.*
Lord Armstrong dares to doubt *me!*
Thomas Alva E.
Say's Salisbury's an electrician
too serene to be moved
by *me!*
We'll see
Cleveland and *me*
Or my name's not T.A.E.

A.M.I.C.E.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free*, 8½*d. (in stamps.)*]

NEW PATENTS.—1895.

6,565A. "Improvements connected with the electrolysis of chlorides and other salts and the evaporation of solutions." H. Tee. Dated December 19th. [Date claimed under Patents Rule, 19, March 30th, 1895.]

24,049. "Improvements in electrical contacts." A. J. Moulart and A. de Galard. Dated December 16th.

24,055. "Improvements in the construction of electric cable joint boxes, more especially for those of concentric type." R. C. Quin. Dated December 16th.

24,079. "Improvements in collectors for electric railways and tramways." W. E. Parry. (J. Parry, United States.) Dated December 16th.

24,092. "Contact apparatus for night and sound signalling and telegraphing." C. Vreede. Dated December 16th.

24,098. "Improvements in continuous current generator dynamos or motor dynamos." A. De Puydt and M. Poncin. Dated December 16th.

24,136. "An automatic check or governor for controlling the trolley (trolley wire system of electric traction"). H. Brecknell and T. B. Holliday. Dated December 17th.

24,151. "An automatic electric fog signal and general danger signal indicator and communicator." W. E. Penfold. Dated December 17th.

24,165. "Process for hardening the active material on the positive plates of secondary voltaic batteries." L. Epstein. Dated December 17th.

24,166. "Improvements in incandescent electric lamps." The Edison & Swan United Electric Light Company, Limited, and E. A. Gimingham. Dated December 17th.

24,172. "Improvements in or connected with galvanic batteries." A. C. Iwanowski. Dated December 17th.

24,222. "Improvements in multiplex telephony." D. Sinclair. Dated December 18th.

24,264. "Resistance switch apparatus for starting electro motors." Siemens, Bros. & Co. (Siemens & Halske, Germany). Dated December 18th.

24,296. "Improvements in or connected with rotary electric transformers." A. B. Blackburn and W. L. Spence. Dated December 18th.

24,300. "Improvements in conduit tramways and rails, and fitttings for the same." J. More, Jun. and G. Flett. Dated December 18th.

24,304. "Improvements in incandescent electric lamps." M. Bailey and J. Wabner. Dated December 18th.

24,354. "Improvements in electrical switches." C. M. Dorman, R. A. Smith, and H. G. Baggs. Dated December 19th.

24,375. "Improvements in electric arc lamps. I. H. Hegner. Dated December 19th.

24,393. "Improvements in reflecting incandescent lamps." A. C. Miles and B. F. de Morgenstern. Dated December 19th.

24,394. "Improvements in and relating to galvanic batteries." A. C. Miles and B. F. de Morgenstern. Dated December 19th.

24,398. "Improvements in means for controlling or directing electric currents." C. Pollak. Dated December 19th.

24,437. "Improvements in electrical and other gas lighters and extinguishers." The Anglo-Swedish Trading Association, and O. E. Wollert. Dated December 20th.

24,443. "Improvements in portable electric lamps for use in mines and other places." S. F. Walker. Dated December 20th.

24,444. "Improvements in holders for electric glow lamps and analogous electrical contact devices." E. Hungerbuhler and The Electrical Co., Limited. Dated December 20th.

24,447. "Improvements in and separation from their cathodes of electrolytically precipitated gold and silver from cyanide solutions." C. M. Pielsticker. Dated December 20th.

24,465. "An improved electric contact button." A. C. Miles and B. F. de Morgenstern. Dated December 20th.

24,466. "Improvements in electric indicators." A. C. Miles and B. F. de Morgenstern. Dated December 20th.

24,467. "Improvements in incandescent lamps." A. C. Miles and B. F. de Morgenstern. Dated December 20th.

24,471. "Improvements in devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause." V. A. Fynn and Easton, Anderson & Goolden, Limited. Dated December 20th.

24,472. "Improvements in dynamo electric machines." V. A. Fynn and Easton, Anderson & Goolden, Ltd. Dated December 20th.

24,473. "Improvements in or connected with incandescence lamps and filaments therefor." C. H. Stearn. Dated December 20th.

24,503. "Improved electrical insulators." R. Atherton. Dated December 21st.

24,514. "Improvements in means or devices for holding electric, incandescent or glow lamps." R. Hacking and J. Bennett. Dated December 21st.

24,516. "Improvements in secondary voltaic batteries." L. Epstein. Dated December 21st.

24,539. "Improvements in electric regulators." A. C. Miles and B. F. de Morgenstern. Dated December 21st.

24,556. "Improvements in suspension devices for electric and other lamps." E. Jullien. Dated December 21st.

ERRATUM.

Electrical Review.—No. 942, page 751, *delete* "No. 20,925A" *and substitute* "No. 22,450" therefor; also *delete* "(Date claimed under patents rules 19, November 5th, 1895.)"

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1894.

523. "An improvement in lightning arresters." R. Belfield. (The Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., U.S.A.) Dated January 8th. A part of the arrester is made of lignum vitæ having a charred grooved surface which will conduct the current to earth from a lightning discharge, but across which no arc can be formed which might permanently earth the unprotected wire. 1 claim.

1,714. "An improvement in electrical glow lamps." Siemens Bros. & Co., Ltd. (Siemens & Halske, Berlin.) Dated January 24th. In electrical glow lamps, constructing the leading-in wires of a short length of non-oxidisable metal wire, such as platinum, to each end of which is welded or soldered a length of wire of less expensive metal, such as copper or nickel, the platinum wire being sealed in the glass in such manner that both points of union are completely embedded in the glass. 1 claim.

1895.

42. "Improvements in and connected with telephonic apparatus as adapted to mining and other purposes." M. Binswanger. Dated January 1st. The entire apparatus is enclosed in an air and dust-tight case, the leads, levers, &c., passing through stuffing boxes into the case. 4 claims.

2,228. "An improved combined starting, reversing, and controlling electric switch for operating electric motors." W. A. Clutworthy. Eaton House, Neasden. Dated January 31st. Consists of an arrangement of contacts and circuits, so that by the operation of one switch handle, the various arrangements of circuits to go "ahead fast" and "astern fast" with batteries in series, and "ahead slow" or "astern slow" with batteries "in parallel" are effected, the circuits being also automatically broken between the position for "ahead" or "astern." Three distinct series of contact blocks are provided all simultaneously operated, in their due order, by the single motion of the switch handle, from right to left, or left to right. 4 claims.